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North Star Navigation

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> . . . *the northern star,*
> *Of whose true fix'd and resting quality*
> *There is no fellow in the firmament.*
> —Shak., Jul. Caes., iii, 1.

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PREFACE

The earliest recorded reference to the art of navigation seems to be the mention in Homer of the departure of Odysseus from the island of Calypso.* The hero is described as watching the constellations all night long, and as guiding his course by the Bear, ''which men also call the Wain, and which has no part in the baths of Ocean.'' Ever since this time, navigators have found special use for those stars, which, like the Bear, ''have no part in the baths of Ocean.'' Chiefest of all is the North Star itself, which, although it has not the ''true-fix'd and resting quality'' ascribed to it by another great poet, is, nevertheless, the most important body, next to the sun, in the seaman's calendar. Lines drawn from the North Star to other stars more distant from the pole, may be regarded as the hands of a giant clock face, keeping time through the ages with an accuracy to which no human mechanism can approximate. The sailor who can read the time so indicated has nearly all the data needed to give him his position.

The present little work began as an attempt to read this time. In the progress of the investigation, it was found that the same calculations which give the longitude, would, with a slight extension, give the latitude also, and that the azimuth of Polaris came out as a sort of by-product. It is believed that the method here described constitutes, both in accuracy and in brevity, a substantial improvement upon previous methods. The particular advantages claimed for it are set out in the last chapter.

The practical seaman may be disposed to complain of the excessive mathematical apparatus which has been employed. But in actual use, all this mathematical scaffolding may be discarded. Indeed, if the reader be willing to take the mathematics on trust, he may turn at once to the worked examples in Chapter V, and by referring for the meaning of the symbols to the table on page 9, he may quickly learn how to make the very simple computations that are needed. One merit of the procedure is that it is the same for all cases and is entirely general. The computer may put in his data, start the machine, and it will grind out the result with only the attention needed to conform to the elementary rules of mathematics.

Special thanks are due to Miss Flora H. MacIvor, of Teachers College, for efficient and untiring assistance in the calculation of the tables.

These tables have been prepared for the year 1925. Should the public demand justify it, supplements covering the succeeding years will be issued.

L. M. B.

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* Hom. Od., V, 270.

5

DEDICATED
TO
THE GOODLY FELLOWSHIP OF MARINERS
THROUGHOUT ALL THE WORLD

. . . di naviganti audace stuolo,
Che mova a ricercar estranio lido,
E in mar dubbioso e sotto ignoto polo
Provi l' onde fallaci e 'l vento infido.
—Tasso, Gerus. Lib., iii, 4.

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ABBREVIATIONS AND SYMBOLS

$a =$ altitude of North Star.

$a_1 =$ first latitude correction; $\sin a_1 = \cos d \cos p$.

$a_2 =$ second latitude correction; given in Table III; $a_2 = \frac{1}{2} \frac{\cos^2 d \sin^2 p \sin a}{\cos (a + a_1)}$.

Note that a_2 is always positive and subtractive.

$a_S =$ altitude of comparison star (the star selected for comparison with the North Star).

$A_z =$ azimuth of North Star.

$c = \mathrm{NS} =$ distance from North Star to comparison star; given in Table VII.

Corr. = correction added to interval of mean solar time to convert it into sidereal time (Amer. Naut. Alm., Table III).

$d =$ declination of North Star.

$d_S =$ declination of comparison star.

G. C. T. = Greenwich civil time (reckoned from midnight (0^h) continuously up to 24^h).

Gr. = Greenwich.

$H =$ Greenwich hour angle of North Star = sid. time of 0^h G. C. T. + G. C. T. + Corr. — RAN.

$h =$ local hour angle of North Star.

Lat. = latitude $= \varphi = a + x = a + a_1 - a_2 = a + \cos d \cos p - \frac{1}{2} \frac{\cos^2 d \sin^2 p \sin a}{\cos (a + a_1)}$.

Long. = longitude $= H - h =$ G. C. T. + Corr. + sid. time of 0^h G. C. T. + 180° — $(\mathrm{RAN} + n + p_S) \pm \vartheta$.

$m =$ difference between R. A. of North Star and R. A. of comparison star.

$n =$ angle SNP; given in Table VII in form RAN $+ n$.

$p =$ position angle of pole; $p = p_S + n$. If $p < 180°$, $p < h$; if $p > 180°$, $p > h$.

$p_S =$ position angle of comparison star.

$\varphi =$ latitude $= a + x = a + a_1 - a_2 = a + \cos d \cos p - \frac{1}{2} \frac{\cos^2 d \sin^2 p \sin a}{\cos (a + a_1)}$.

R. A. = right ascension.

RAN = right ascension of North Star; given in Table VI.

sid. = sidereal.

$\vartheta =$ small angle by which $p \sim h$ exceeds 180°; $p \sim h = 180° + \vartheta$; $\vartheta = \vartheta_1 \pm \vartheta_2$.

$\vartheta_1 =$ first approximation to ϑ; $\sin \vartheta_1 = \cos d \sin p \tan \varphi = \sin a_1 \tan p \tan \varphi$.

$\vartheta_2 =$ correction to ϑ_1; $\vartheta_2 = \pm .0000925 \sin 2p$; given in Table IV.

$x =$ correction to be added to a to give φ; $\varphi = a + x$; $x = a_1 - a_2$.

CHAPTER I.

POSITION ANGLES

§ 1. *Definition of Position Angle.*

The term "position angle" is well known in astronomy; but in this work the phrase will be employed somewhat differently from the ordinary astronomical practice, and the use of the term will be confined to angles measured with reference to the North Star alone. Briefly, a position angle is what an hour angle would be, if hour angles were measured with reference to Polaris instead of the pole. To illustrate, let us suppose the observer to be reclining in a rocking chair, surveying the northern sky from the pole star to the zenith. Let P (fig. 1) be the pole, Z the zenith, N the north star, and S some other star. Let ZN be a vertical circle passing through N. Then by the position angle of S we mean the angle ZNS which the great circle through S and N makes with the vertical circle through N.

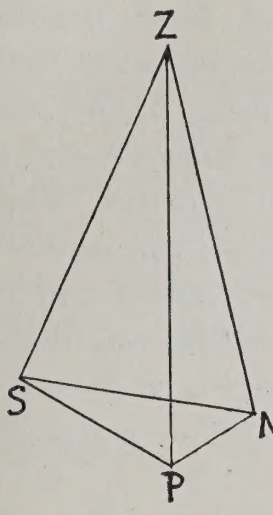

FIG. 1

Position angles, as they appear to an observer looking at the north pole, are measured counterclockwise (or westwardly) from the arc (of the great circle) which connects the zenith with the North Star. This is the direction in which the circumpolar stars appear to revolve, and this method of measurement corresponds to the astronomical practice in respect to hour angles.

The counterclockwise direction is deemed the positive direction of the position angle; and the clockwise direction is considered negative. Position angles are reckoned from 0° to 360°; but where they exceed 180°, it is sometimes more convenient to measure them in the clockwise direction, and prefix the minus sign. On the other hand, where a negative position angle occurs, it is often best to get rid of the minus sign by adding 360° (which does not alter the directional value of the angle).

The plane of the vertical circle from which position angles are measured, is, of course, always perpendicular to the horizon.

It will be shown, hereafter, that the use of position angles greatly facilitates computations for latitude and longitude. The latitude, the longitude, and the azimuth of Polaris, may all be expressed as functions, in part, of the position angle of the pole; and this position angle being once obtained, the other three quantities may be arrived at by very brief and very simple calculations.

§ 2. *Equation for determining Position Angle.*

Obviously, the simplest method of determining a position angle would be by direct measurement. An instrument for that purpose is a desideratum which it is hoped that some inventor may soon supply.

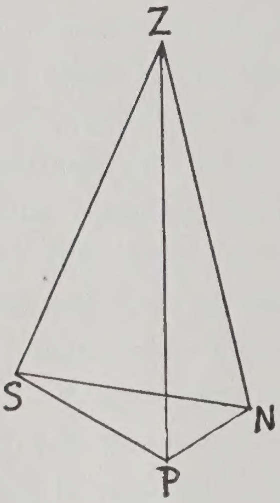

FIG. 2

But the position angle of any selected star can also be determined by the simultaneous measurement of two altitudes, one of the star in question, and one of Polaris. In fig. 2, which represents the sky around the pole as the observer looks at it from the earth, P is the pole; Z, the zenith; N, the North Star; and S, any other selected star, of which the position angle is desired. Let the desired position angle $ZNS = p_s$, and let $NS = c$ = distance between the stars N and S (which is easily computed from their celestial coordinates). Let the measured altitudes of N and S be a and a_s, respectively. Then $ZN = 90° - a$ and $ZS = 90° - a_s$.

In the triangle ZNS, $\cos ZS = \cos NS \cos NZ + \sin NS \sin NZ \cos ZNS$

$$\sin a_s = \cos c \sin a + \sin c \cos a \cos p_s \qquad (1)$$

This is the equation for determining the position angle. How to solve the equation for p_s, will be shown presently. First, however, it is desirable to point out the effect upon p_s, of errors in the measured quantities a and a_s.

§ 3. *Effect upon Position Angle of errors in the measured altitudes.*

(1) To find the effect upon p_s of an error in a_s, differentiate eq. (1) in the preceding section, a_s and p_s being the variables, and we get

$$\cos a_s \, da_s = - \sin c \cos a \sin p_s dp_s.$$

$$\therefore \qquad \frac{dp_s}{da_s} = - \frac{\cos a_s}{\sin c \cos a \sin p_s} \qquad (1)$$

But

$$\frac{\sin SZ}{\sin SNZ} = \frac{\sin SN}{\sin SZN}$$

$$\frac{\cos a_s}{\sin p_s} = \frac{\sin c}{\sin SZN}$$

Substituting in (1),

$$\frac{dp_s}{da_s} = -\frac{1}{\sin c \cos a} \cdot \frac{\sin c}{\sin SZN}$$

$$= -\frac{1}{\cos a \sin SZN} \qquad (2)$$

The angle SZN is the difference in azimuth of the two stars. It is obvious that dp_s/da_s will be numerically smallest when $\cos a \sin SZN$ is a maximum, *i.e.*, when SZN is close to 90°.

(2) To find the effect upon p_s of an error in a, differentiate eq. (1), § 2, a and p_s being the variables, and we get

$$0 = \cos c \cos a da - \sin c \sin a da \cos p_s - \sin c \cos a \sin p_s dp_s$$

$$\therefore \qquad \frac{dp_s}{da} = \frac{\cos c \cos a - \sin c \sin a \cos p_s}{\sin c \cos a \sin p_s} \qquad (3)$$

In any spherical triangle ABC,

$$\sin a \cos B = \cos b \sin c - \sin b \cos c \cos A$$

Applying this formula to the triangle NZS,

$$\sin ZS \cos SZN = \cos SN \sin ZN - \sin SN \cos ZN \cos ZNS$$

$$\cos a_s \cos SZN = \cos c \cos a - \sin c \sin a \cos p_s.$$

Substituting in (3),

$$\frac{dp_s}{da} = \frac{\cos a_s \cos SZN}{\sin c \cos a \sin p_s}$$

But, as before,

$$\frac{\cos a_s}{\sin p_s} = -\frac{\sin c}{\sin SZN}$$

$$\therefore \qquad \frac{dp_s}{da} = \frac{\cos SZN}{\sin c \cos a} \cdot \frac{\sin c}{\sin SZN} = \frac{1}{\cos a \tan SZN} \qquad (4)$$

Here, again, dp_s/da will be a minimum, when SZN is close to 90°.

Hence the condition for a favorable observation will be to select a star such that SZN is close to 90°; or, in other words, ZN being almost coincident with the observer's meridian, to select a star bearing nearly east or west of the observer. A difference in azimuth of from 10° to 40° more or less than 90° makes a difference which is indicated in the following little table (computed for $a = 45°$):

	$SZN = 90°$	$SZN = 80°$	$SZN = 70°$	$SZN = 60°$	$SZN = 50°$
dp_s/da_s	-1.41	-1.44	-1.51	-1.63	-1.85
dp_s/da	0.00	0.25	0.51	0.82	1.19

This table also shows that in measuring the altitudes of the two stars, it is more important to get a correct measurement for the comparison star than for the North Star.

§ 4. *Solution of Equation for Position Angle.*

Eq. (1), § 2, solved for p_s, gives

$$\cos p_s = \frac{\sin a_s - \cos c \sin a}{\sin c \cos a} = \operatorname{cosec} c \sec a \sin a_s - \cot c \tan a.$$

The above is in form for subtraction logarithms. If these are not at hand, the following method may be used:

$$1 - \cos p_s = \frac{\sin c \cos a + \cos c \sin a - \sin a_s}{\sin c \cos a}$$

$$\operatorname{versin} p_s = \frac{\sin (a + c) - \sin a_s}{\sin c \cos a}$$

$$2 \operatorname{hav} p_s = \frac{2 \cos \tfrac{1}{2} (a + c + a_s) \sin \tfrac{1}{2} (a + c - a_s)}{\sin c \cos a}$$

$$\operatorname{hav} p_s = \frac{\cos s \sin (s - a_s)}{\sin c \cos a}, \text{ where } s = \tfrac{1}{2} (a + c + a_s)$$

$$= \sec a \operatorname{cosec} c \cos s \sin (s - a_s) \qquad (1)$$

In the above formula, c is the distance from the North Star to the selected star. It is a nearly constant quantity, which may be computed from the coordinates of the two stars. It is given in Table VII.

In using the formula, it is to be remembered that $\operatorname{hav} p_s = \operatorname{hav} (360° - p_s)$. Hence the equation will always give two values for p_s, one less than 180°, and the other greater than 180°. The proper value for the case in hand may be chosen by noticing whether the selected star is east or west of the North Star. If it is east, p_s will be greater than 180°; if it is west, p_s will be less than 180°. This criterion will determine which of the two values of p_s is to be taken.

As an example, let us suppose that on August 6, 1925, the altitude of Polaris is measured and (after correction) is found to be 33° 20′, and the altitude of Vega, 64° 38′. Vega is in the west. What is its position angle?

Referring to the table for Vega (page 82), we get $c = 51° \ 34'.7$ and $\log \operatorname{cosec} c = .10598$.

a_s	64° 38′		
a	33° 20′	sec a	.07806
c	51° 34′.7	cosec c	.10598
	2)148° 92′.7		
s	74° 46′.3	cos s	9.41940
$s - a_s$	10° 8′.3	sin $(s - a_s)$	9.24557
		hav p_s	8.84901
		$p_s =$	30° 49′.5, or
			329° 10′.5

Vega being in the west, its position angle is less than 180°. Hence $p_s = 30° \ 49'.5$.

As another example, let us suppose that on June 11, 1925, the altitude of Polaris is found to be 39° 46′, and the altitude of Altair (which is in the east) is 29° 55′.8. What is the position angle of Altair?

From the table for Altair (page 82), $c = 81° \ 16'.1$, and $\log \operatorname{cosec} c = .00506$.

a_s	29° 55′.8		
a	39° 46′.0	$\sec a$	.11427
c	81° 16′.1	$\operatorname{cosec} c$	.00506
	2)150° 57′.9		
s	75° 28′.9	$\cos s$	9.39914
$s - a_s$	45° 33′.1	$\sin (s - a_s)$	9.85362
		$\operatorname{hav} p_s$	9.37209
		$p_s =$	58° 4′.2, or
			301° 55′.8

Since Altair is in the east, its position angle is obviously greater than 180°. Therefore take $p_s = 301° \ 55'.8$.

§ 5. *To find the position angle of the pole.*

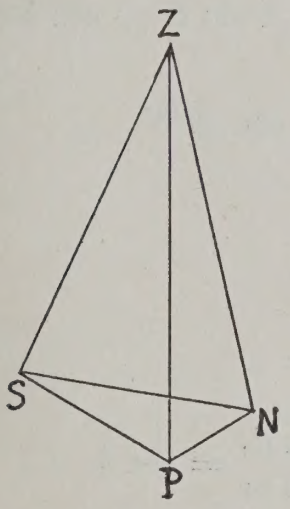

FIG. 3

We shall show in the next two chapters that when the position angle of the pole (ZNP in the annexed figure) is once known, the latitude and longitude may both be obtained by very simple calculations. Our object now is to show how to obtain ZNP, which we shall call p.

Obviously, $ZNP = ZNS + SNP$, where $ZNS = p_s =$ the position angle of the selected star, computed as shown just above, and $SNP = n$ (say), where n is measured around N counterclockwise from SN as the initial line to NP, and varies from 0° to 360°. By this conventional system of measurement, $p = p_s + n$, for all situations, it being understood that if the sum of p_s and n is more than 360°, the angle p is taken as the excess over 360°. This is apparent from figs. 3, 4, 5, 6, in all of which the sum of ZNS and SNP (both angles being measured counterclockwise) is either ZNP or $ZNP + 360°$.

The angle n may be computed in advance from the known coordinates of Polaris and the selected star. If we have already computed $SN = c =$ distance between the two stars, we have

$$\sin SNP = \frac{\sin SP \sin SPN}{\sin SN} = \frac{\cos d_s \sin m}{\sin c}$$

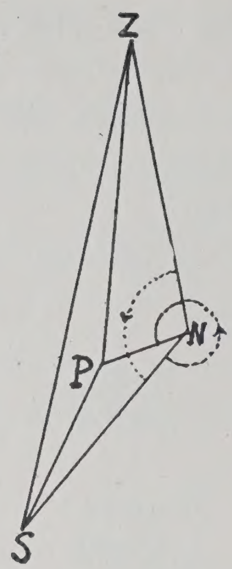

FIG. 4

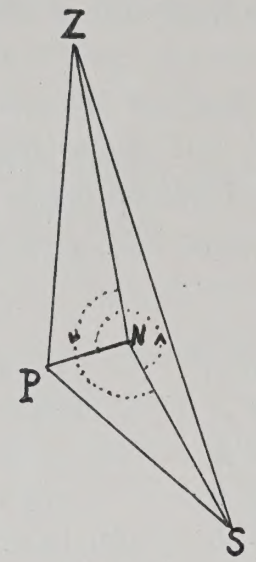

FIG. 5

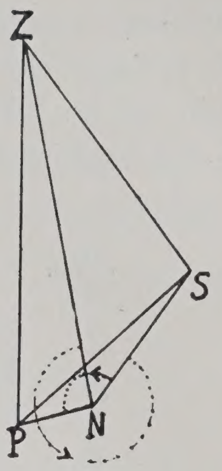

FIG. 6

where $m = SPN$ is obtained by taking the difference of the right ascensions of the two stars.

$$\therefore \qquad \sin n = \cos d_s \sin m \operatorname{cosec} c$$

If n is close to 90° or 270°, the above formula is not well adapted, and we may use the following:

In any spherical triangle ABC, $\cot a \sin b = \cot A \sin C + \cos b \cos C$. Applying this formula to the triangle NPS,

$$\cot SP \sin PN = \cot SNP \sin SPN + \cos PN \cos SPN$$
$$\tan d_s \cos d = \cot n \sin m + \sin d \cos m$$

$$\begin{aligned}
\cot n &= \frac{\cos d \tan d_s - \sin d \cos m}{\sin m} \\
&= \frac{\cos m}{\sin m}\left(\frac{\cos d \tan d_s}{\cos m} - \sin d\right) \\
&= \cot m\ (\cos d \cot \vartheta - \sin d), \text{ where } \frac{\tan d_s}{\cos m} = \cot \vartheta \\
&= \cot m\left(\frac{\cos d \cos \vartheta - \sin d \sin \vartheta}{\sin \vartheta}\right) \\
&= \frac{\cot m \cos (d + \vartheta)}{\sin \vartheta}
\end{aligned}$$

$$\therefore \qquad \tan n = \frac{\sin \vartheta \tan m}{\cos (d + \vartheta)}, \text{ where } \tan \vartheta = \frac{\cos m}{\tan d_s}$$

The angle n varies somewhat rapidly from day to day; but it varies in an opposite sense to the right ascension of the North Star, which we call RAN. Therefore, $RAN + n$ is practically constant over any small number of days. For this reason, we have chosen $RAN + n$ as the quantity to be tabulated in our star tables (pages 75 *et seq.*). To obtain n, it is only necessary to subtract from $RAN + n$ the value of RAN, given in Table VI. This table gives RAN for the upper transit of Polaris at Greenwich. Hence the value of n, obtained as just indicated, is the value for the same moment of time, namely, the upper transit of Polaris at Greenwich.

CHAPTER II

LATITUDE

§ 6. *Introductory Remarks.*

The method for finding latitude and longitude, which we are about to describe, is an extension and abbreviation of the so-called method of double altitudes. It consists in measuring simultaneously the altitude of the North Star and the altitude of some other star, selected for comparison. If there is only one observer, he measures first the altitude of the North Star, then the altitude of the comparison star, and finally the altitude of the North Star again, noting the time of each observation. Then by a simple interpolation, the altitude of the North Star at the time of the second observation may be obtained. These two altitudes are taken as the data to work from, and they suffice to determine the latitude, the longitude, and the azimuth of the North Star, very simply and without recourse to dead reckoning. Latitude is considered first.

§ 7. *The Latitude Equation.*

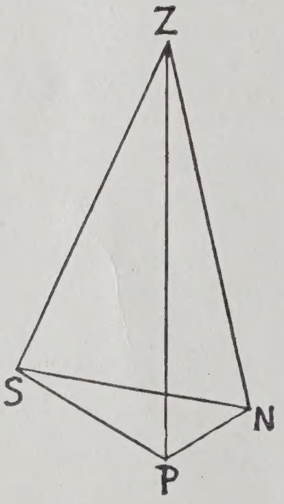

FIG. 7

Let the figure represent the region around the North Pole, as the observer sees it. Let P be the pole, N the North Star, S the comparison star, and Z the zenith. Then in the triangle ZPN,

$$\cos PZ = \cos PN \cos NZ + \sin PN \sin NZ \cos PNZ.$$

If φ is the latitude, a the altitude of the North Star, d its declination, and p the position angle of the pole, the above equation becomes

$$\sin \varphi = \sin d \sin a + \cos d \cos a \cos p \qquad (1)$$

This is the latitude equation. It determines the latitude φ from the given quantities a and p. We shall show in a moment how to solve it, but shall first inquire as to the effect upon φ of errors in the quantities p and a.

§ 8. *Effect upon Latitude of Errors in Altitude and in Position Angle.*

(1) To find the effect upon φ of an error in p:

Differentiating eq. (1), § 7, φ and p being the variables,

$$\cos \varphi \frac{d\varphi}{dp} = - \cos d \cos a \sin p$$

$$\therefore \qquad \frac{d\varphi}{dp} = - \frac{\cos a \cos d \sin p}{\cos \varphi}$$

But in the triangle *ZPN*,

$$\sin PZN = \frac{\sin PN \sin PNZ}{\sin PZ}$$

$$\therefore \qquad \sin PZN = \frac{\cos d \sin p}{\cos \varphi}$$

$$\therefore \qquad \frac{d\varphi}{dp} = - \cos a \sin PZN \tag{1}$$

This value of $d\varphi/dp$ will be numerically greatest when the two factors composing it, cos *a* and sin *PZN*, are each a maximum.

The factor cos *a* will be a maximum when *a* is a minimum; and, for practical purposes, *a* is a minimum at about 10°, since the irregularities in the refraction of light proceeding from stars near the horizon render altitude measurements of less than 10° unreliable.

The factor sin *PZN* is a maximum when the angle *PZN* is greatest, and this occurs when the angle *PNZ* is a right angle, in which case $\sin PN = \sin PZ \sin PZN$, or,

$$\sin PZN = \frac{\sin PN}{\sin PZ} = \frac{\cos d}{\cos \varphi} = \cos d \sec \varphi$$

In the temperate zone, φ does not exceed 66° 33′; and d (for 1925) $= 88° \ 54'.2$. Hence, the maximum numerical value of $d\varphi/dp$ is (for the temperate zone)

$$\frac{d\varphi}{dp} = - \cos a \cos d \sec \varphi = - \cos (10°) \cos (88° \ 54'.2) \sec (66° \ 33')$$
$$= - 0.042$$

This result shows that, in the temperate zone, the error in the latitude due to an error in the position angle, is about four per cent. of the latter error, and reaches this limit only as the observer approaches the arctic zone, so that even in this extreme case, the position angle may be wrong to the extent of nearly 24′, and still occasion an error of only 1′ in the latitude.

In the more usual case, where the latitude is (say) 45° and $a = 45°$, $d\varphi/dp = - 0.019$.

In other words, in the case just supposed, the position angle may be 53′ out of the way, and still give the latitude with an error of no more than 1′.

We conclude, therefore, that eq. (1), § 7, furnishes a very advantageous medium for the determination of the latitude.

(2) To find the effect upon φ of an error in a:

Differentiating eq. (1), §7, with respect to a,

$$\cos\varphi\frac{d\varphi}{da}=\sin d\cos a-\cos d\sin a\cos p$$

$$\therefore\quad \frac{d\varphi}{da}=\frac{\sin d\cos a-\cos d\sin a\cos p}{\cos\varphi}\qquad(2)$$

In any spherical triangle ABC, $\sin a\cos B=\cos b\sin c-\sin b\cos c\cos A$. Applying this formula to the spherical triangle NZP,

$$\sin PZ\ \cos PZN=\cos PN\ \sin ZN-\sin PN\ \cos ZN\ \cos ZNP$$
$$\cos\varphi\ \cos PZN=\sin d\cos a-\cos d\sin a\cos p$$

Substituting this value in (2),

$$\frac{d\varphi}{da}=\frac{\cos\varphi\cos PZN}{\cos\varphi}=\cos PZN$$

In the temperate zone, the angle PZN, as shown above, varies from 0° to its maximum value, which occurs where

$\sin PZN=\cos d\sec\varphi=\cos(88°\ 54'.2)\sec(66°\ 33')$, or $PZN=2°\ 45'.4$

As the angle PZN varies from 0° to 2° 45′.4, cos PZN varies from 1 to 0.9988; and so $d\varphi/da$ is practically equal to unity for all places in the temperate zone. It follows that, anywhere in the temperate zone, an error in the altitude is reproduced in the latitude merely to the same extent, without enhancement.

§ 9. *Solution of Latitude Equation. Latitude Correction* (a_2).

We shall now show how to solve the latitude equation,

$$\sin\varphi=\sin d\sin a+\cos d\cos a\cos p.$$

Factoring,

$$\sin\varphi=\sin d\,(\sin a+\cot d\cos a\cos p)$$

Putting $\cot d\cos p=\tan a_1=\frac{\sin a_1}{\cos a_1}$, we have

$$\sin\varphi=\sin d\left(\sin a+\cos a\frac{\sin a_1}{\cos a_1}\right)$$

$$=\frac{\sin d\sin(a+a_1)}{\cos a_1},\ \text{where}\ \tan a_1=\cot d\cos p$$

These equations give φ, as soon as p is known; and how p is obtained, has been shown in § 5.

As an example, let us suppose that on June 11, 1925, the altitude of Polaris is 39° 46′, and the position angle of Altair (which is in the east) is 301° 55′.8, as computed on page 15. What is the latitude?

From the table for Altair (page 82) we find $RAN + n = 116° 37'.2$. Adding $p_s = 301° 55'.8$, we get $RAN + n + p_s = 418° 33'$, or, dropping 360°, 58° 33′. Subtracting from this, $RAN = 23° 29'.9$ (given in Table VI), we get $n + p_s = 35° 3'$. But $n + p_s = p$. Hence $p = 35° 3'$. From the Nautical Almanac, $d = 88° 53'.9$.

The equations are

$$\sin \varphi = \frac{\sin d \sin (a + a_1)}{\cos a_1} \qquad (1)$$

$$\tan a_1 = \cot d \cos p \qquad (2)$$

The work may be arranged as follows:

p	35° 3′	$\cos p$	9.91310		
d	88° 53′.9	$\cot d$	8.28398	$\sin d$	9.99992
a_1	0° 54′.1	$\tan a_1$	8.19708	$\sec a_1$	.00005
a	39° 46′.0			$\sin(a + a_1)$	9.81403
$a + a_1$	40° 40′.1			$\sin \varphi$	9.81400
					$\varphi = 40° 39'.9$

The above has been worked in full, but, for practical purposes, the process may be greatly abbreviated.

Taking logarithms of eq. (1), $\log \sin \varphi = \log \sin d + \log \sin (a + a_1) - \log \cos a_1$

$$\therefore \qquad \log \sin (a + a_1) - \log \sin \varphi = \log \cos a_1 - \log \sin d$$

Now φ is only a little less than $a + a_1$, and $\log \sin (a + a_1) - \log \sin \varphi$, in the above example, is .00003. In the table of logarithmic sines at this point of the quadrant, the tabular difference for 1′ is 15. Hence φ is less than $a + a_1$ by 3/15 of a minute, *i.e.*, by 0′.2. We may call this small arc a_2, and may tabulate its values for various values of $a + a_1$ and p. This is done in Table III. Hence $\varphi = a + a_1 - a_2$. Therefore, to find the latitude, compute a_1 from the equation $\tan a_1 = \cot d \cos p$; then add a_1 to a; then look out in Table III the proper value of a_2 for $a + a_1$; and finally subtract this value from $a + a_1$. Accordingly, the solution of the example takes the following extremely simple form:

	p	35° 3′	$\cos p$	9.9131
	d	88° 53′.9	$\cot d$	8.2840
	a_1	0° 54′.1	$\tan a_1$	8.1971
	a	39° 46′.0		
	$a + a_1$	40° 40′.1		
(From Table III, page 66)	a_2	—′.2		
	φ	40° 39′.9		

For computing a_1, four-figure logarithms will be amply sufficient.

Since a_1 is always small, its tangent is practically equal to its sine; and since d is close to 90°, its cotangent is practically equal to its cosine. Hence for computing a_1, we may change the formula $\tan a_1 = \cot d \cos p$ to $\sin a_1 = \cos d \cos p$.

The practical advantage of these changes, which do not affect the result to any extent that is material in navigation, will appear hereafter.

Table VI gives $\cos d$ for each day in the year 1925.

As another example, let us suppose that on August 6, 1925, the altitude of Polaris is 33° 20′, and the position angle of Vega (which is in the west) is 30° 49′.5, as previously computed on page 14. What is the latitude?

$$\begin{array}{lrrll}
\text{(From Table VII, page 82)} & RAN + n = & 97^\circ\ 45'.8 & & \\
 & p_s = & 30^\circ\ 49'.5 & & \\
 & RAN + n + p_s = & 128^\circ\ 35'.3 & & \\
 & & & & \\
\text{(From Table VI, page 72)} & RAN = & 23^\circ\ 45'.1 & \cos d & 8.2836 \\
 & n + p_s = p = & 104^\circ\ 50'.2 & \cos p & \underline{9.4084\ (n)} \\
 & a_1 = & -0^\circ\ 16'.9 & \sin a_1 & 7.6920\ (n) \\
 & a = & 33^\circ\ 20'.0 & & \\
 & a + a_1 = & 33^\circ\ \ 3'.1 & & \\
 & & & & \\
\text{(From Table III, page 69)} & a_2 = & -'.4 & & \\
 & \varphi = & 33^\circ\ \ 2'.7 & &
\end{array}$$

In the above example, $\sin a_1$ comes out minus. Now $-\sin A = \sin(-A)$, and also $-\sin A = \sin(180^\circ + A)$. But the latter possibility is excluded here, for a_1 is very small. Hence a_1 must be taken as a minus angle, $-0^\circ\ 16'.9$.

§ 10. *Algebraic Method of Computing Latitude Correction* (a_2).

We have shown just above how a_2 may be computed by means of the logarithmic tables. It may also be found algebraically, as follows:

The formula for latitude is

$$\sin \varphi = \sin d \sin a + \cos d \cos a \cos p$$

Let $\varphi = a + x$, where x is a small correction to be added to the altitude of Polaris to get the latitude. Then

$$\sin a \cos x + \cos a \sin x = \sin d \sin a + \cos d \cos a \cos p$$

Dividing by $\cos a$,

$$\tan a \cos x + \sin x = \sin d \tan a + \cos d \cos p$$

Since x is small, never exceeding 1° 5′ 48″.88 (for 1925), we may make the following substitutions:

$$\sin x = x - \frac{x^3}{6}$$

$$\cos x = 1 - \frac{x^2}{2}$$

$$\therefore \qquad \tan a - \tan a \frac{x^2}{2} + x - \frac{x^3}{6} = \sin d \tan a + \cos d \cos p$$

Now $\frac{x^3}{6}$ is never greater than .0000012, a quantity so close to zero that we may drop it, and write

$$\tan a - \tan a \frac{x^2}{2} + x = \sin d \tan a + \cos d \cos p$$

$$1 - \frac{x^2}{2} + x \cot a = \sin d + \cos d \cos p \cot a$$

$$x^2 - 2x \cot a = 2\,(1 - \sin d) - 2 \cos d \cos p \cot a$$

Again, d being 88° 54′ 11″.12, we find by calculation that

$$\begin{aligned} 2(1 - \sin d) &= .0003666, \text{ and} \\ \cos^2 d &= .0003665 \end{aligned}$$

Hence $2\,(1 - \sin d) = \cos^2 d$

$$\therefore \qquad x^2 - 2x \cot a = \cos^2 d - 2 \cos d \cos p \cot a$$

$$x^2 - 2x \cot a + \cot^2 a = \cot^2 a + \cos^2 d - 2 \cot a \cos d \cos p$$

$$(\cot a - x)^2 = \cot^2 a + \cos^2 d - 2 \cot a \cos d \cos p$$

This equation is in proper form for the application of the formula (proved in Trigonometry) for the development of $c^2 = a^2 + b^2 - 2ab \cos C$. The result is the series

$$\log c = \log a - \frac{b}{a} \cos C - \frac{b^2}{2a^2} \cos 2C - \frac{b^3}{3a^3} \cos 3C + \ldots.$$

In practice, however, the above series is not convenient; and the following method is preferable:

$$(\cot a - x)^2 = (\cot a - \cos d \cos p)^2 - \cos^2 d \cos^2 p + \cos^2 d$$

$$= (\cot a - \cos d \cos p)^2 \left\{ 1 + \frac{\cos^2 d \sin^2 p}{(\cot a - \cos d \cos p)^2} \right\}$$

$$\cot a - x = \pm\, (\cot a - \cos d \cos p) \left\{ 1 + \frac{1}{2} \frac{\cos^2 d \sin^2 p}{(\cot a - \cos d \cos p)^2} - \frac{1}{8} \frac{\cos^4 d \sin^4 p}{(\cot a - \cos d \cos p)^4} \right\}$$

$$= \pm \left\{ \cot a - \cos d \cos p + \frac{1}{2} \frac{\cos^2 d \sin^2 p}{\cot a - \cos d \cos p} - \frac{1}{8} \frac{\cos^4 d \sin^4 p}{(\cot a - \cos d \cos p)^3} \right\}$$

The minus value would make x impossibly large; we therefore take the plus value, and get

$$x = \cos d \cos p - \frac{1}{2}\frac{\cos^2 d \sin^2 p}{\cot a - \cos d \cos p} + \frac{1}{8}\frac{\cos^4 d \sin^4 p}{(\cot a - \cos d \cos p)^3}$$

The last term is, at greatest, so small as to be negligible. The analytical proof of this statement is somewhat lengthy; but the proposition may be shown, for practical purposes, quite simply. The fraction is greatest when the numerator is a maximum and the denominator a minimum. The numerator is a maximum when $p = 90°$; and the denominator is a minimum (for the temperate zone) when $p = 0°$, and $a = 66° \; 33'$. These values are, of course, not simultaneous, and the fraction never has so large a value as these give. Yet even with these values, the fraction, which then becomes $\frac{1}{8}\cdot\frac{\cos^4 d}{(\cot a - \cos d)^3}$, is, when evaluated, .00000024. This is the radian measure for $0''.05$, a quantity wholly negligible. We therefore drop this term, and write

$$x = \cos d \cos p - \frac{1}{2}\frac{\cos^2 d \sin^2 p}{\cot a - \cos d \cos p}$$

or $x = a_1 - a_2$, where $a_1 = \cos d \cos p$, and

$$a_2 = \frac{1}{2}\frac{\cos^2 d \sin^2 p}{\cot a - \cos d \cos p}$$

For logarithmic computation, the term $\frac{1}{2}\frac{\cos^2 d \sin^2 p}{\cot a - \cos d \cos p}$ may be simplified as follows:

Since a_1 is very small, its arc, sine and tangent may be treated as interchangeable.

$$\therefore \cot a - \cos d \cos p = \cot a - a_1 = \cot a - \tan a_1 = \frac{\cos a}{\sin a} - \frac{\sin a_1}{\cos a_1}$$

$$= \frac{\cos (a + a_1)}{\sin a \cos a_1}$$

Hence $a_2 = \frac{1}{2}\frac{\cos^2 d \sin^2 p}{\cot a - \cos d \cos p} = \frac{1}{2}\frac{\cos^2 d \sin^2 p \sin a \cos a_1}{\cos (a + a_1)}$

Now a_1 being small, $\cos a_1 = 1$ (nearly), and we may write:

$$a_2 = \frac{1}{2}\frac{\cos^2 d \sin^2 p \sin a}{\cos (a + a_1)}$$

The closeness of this approximation is shown as follows:

Since $\sin a_1 = \cos d \cos p$, and since $d = 88° \; 54' \; 11''.12$, the maximum value of sin a_1 (occurring where $p = 0$) is sin $a_1 = \cos d = \sin (90° - d)$. Hence the maximum value of a_1 is $90° - d$. Therefore, as a_1 varies from 0° to $90° - d$, cos a_1 varies from 1 to $\cos (90° - d) = \sin d = .9998167 = 1 - .0001833$.

Where cos a_1 has the latter value,

$$a_2 = \frac{1}{2} \frac{\cos^2 d \sin^2 p \sin a \,(1 - .0001833)}{\cos (a + a_1)}$$

$$= \frac{1}{2} \frac{\cos^2 d \sin^2 p \sin a}{\cos (a + a_1)} - \frac{1}{2} \frac{\cos^2 d \sin^2 p \sin a \,(.0001833)}{\cos (a + a_1)}$$

The value of the last fraction is greatest when the numerator is a maximum, and the denominator a minimum, *i.e.*, when $p = 90°$, $a = 66°\ 33'$, and $a_1 = 90° - d$ (which is the largest value of a_1). These substitutions give $0''.02$ for the largest value of the fraction, and it is consequently negligible. Hence we may write

$$a_2 = \frac{1}{2} \frac{\cos^2 d \sin^2 p \sin a}{\cos (a + a_1)}$$

$$\therefore \text{Latitude} = a + a_1 - a_2$$

$$= a + \cos d \cos p - \frac{1}{2} \frac{\cos^2 d \sin^2 p \sin a}{\cos (a + a_1)}$$

The above is the final form of our equation for latitude. The first term (a) is the measured altitude of Polaris. The second term (a_1) is computed from a_1 (or sin a_1) $= \cos d \cos p$, cos d being tabulated in Table VI. The third term (a_2) never exceeds $1'.5$ in the temperate zone, and may ordinarily be neglected. If used, it may be taken from Table III.

CHAPTER III

LONGITUDE

§ 11. *General Formula for Longitude.*

The student will recall that the hour angle of a heavenly body with reference to any given meridian is measured westerly from that meridian. Hence, in the adjoining figure (which represents one half of the celestial sphere), if P is the pole, PM the meridian of the observer, and PG and PN the meridians of Greenwich and of the North Star, respectively, then the hour angle of the North Star with reference to the observer is MN, and with reference to Greenwich is GN. Calling the latter H and the former h, we have

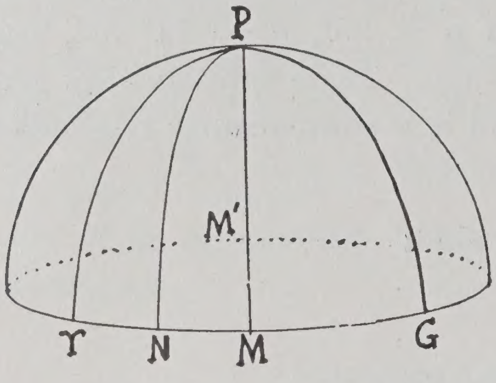

FIG. 8

$$GM = GN - MN.$$
$$\therefore \quad \text{Long.} = H - h.$$

This is a general formula for longitude, and is true of all possible situations. For example, in fig. 9,

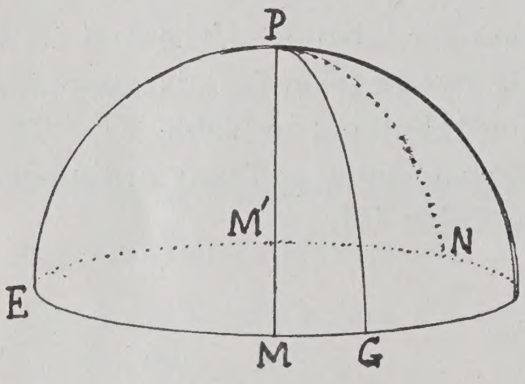

FIG. 9

$$GM = GMEM'N - MEM'N$$
$$\therefore \text{Long.} = H - h.$$

And in fig. 10,

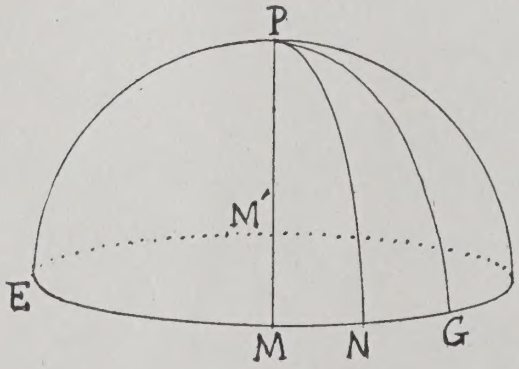

FIG. 10

$$GM = GMEM'GN - MEM'GN$$
$$= 360° + GN - h$$
$$\therefore \quad \text{Long.} = 360° + H - h$$

The last equation is an illustration of the fact that, for practical purposes, the value of an angle is not altered by adding 360° to it. Hence, if in the formula Long. $= H - h$, H is less than h, we add 360° or 24^h to H, and then make the subtraction.

§ 12. *To Find the Greenwich Hour Angle of the North Star.*

In the formula for longitude (Long. $= H - h$), the first term H is the Greenwich hour angle of the North Star, and it is obtained by means of the ship's chronometer; for in fig. 8,

$$H = GN = \Upsilon G - \Upsilon N$$

But ΥG is the sidereal time at Greenwich, and ΥN is the right ascension of the North Star.

The sidereal time at Greenwich at any moment is the sidereal time of Greenwich mean midnight (0^h Greenwich civil time) plus the interval of time that has elapsed since Greenwich mean midnight (the interval being measured in sidereal time). This time interval since Greenwich mean midnight is given by the ship's chronometer in mean solar time. Hence if the correction necessary to reduce mean solar time to sidereal time be represented by "Corr.," the equation will be

$\Upsilon G = G.C.T. +$ Corr. $+$ sid. time of 0^h $G.C.T.$, and
$H = \Upsilon G - \Upsilon N = G.C.T. +$ Corr. $+$ sid. time of 0^h $G.C.T.$ — R.A. of North Star.

This simple equation gives H; and the next step is to find h.

§ 13. *To Find the Local Hour Angle of the North Star. First Method.*

As above shown, H is very easily obtained. The real difficulty is to find h, the local hour angle of Polaris. If the pole were a visible point in the sky, this would be an easy matter. The telescope could be pointed at the pole, and by rotating the tube on its axis, the observer could read off at once, with the help of the spider lines in the field of the view, the position angle of Polaris with reference to the pole, *i.e.*, the hour angle of Polaris. But the pole is invisible; therefore a circuitous procedure is necessary.

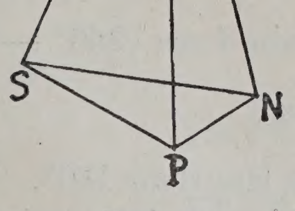

Fig. 11

In the triangle ZPN, $ZP =$ colat., and $ZNP = p$, have just been obtained. Hence,

$$\frac{\sin ZPN}{\sin ZN} = \frac{\sin ZNP}{\sin ZP}$$

$$\frac{\sin (360° - h)}{\cos a} = \frac{\sin p}{\cos \varphi}$$

$$-\sin h = \frac{\sin p \cos a}{\cos \varphi}$$

$$-\sin h = +\sin p \cos a \sec \varphi$$

This equation determines h. In using it, there will always be two alternative values, since

$$-\sin h = \sin (180^\circ + h) = \sin (360^\circ - h).$$

To determine which of the two possible values is the one required, it is sufficient to notice the value of p. If $p < 180^\circ$, $h > 180^\circ$; and if $p > 180^\circ$, $h < 180^\circ$. This will serve to decide between the alternative values of h.

The equation, however, is subject to one defect. Where h is close to 90° or 270°, $\sin h$ varies so slowly that h cannot be determined with the necessary accuracy. Inspection of a five-figure table of logarithmic sines will show that for 15° or 20° either side of 90° or 270°, the angle cannot be determined with accuracy from its sine. It is true that this defect might be obviated to a certain extent by using six or seven place logarithms; but, on the whole, it is better to pursue another course, which, though somewhat prolix in its method of proof, leads in the end to a formula which is quite as simple as the above, and which is free from the defect just mentioned.

§ 14. *Second Method.*

Let the diagram represent the celestial sphere as seen by an observer looking at the north pole. Let P be the pole, Z the zenith, N the north star, and S the other star. After finding $ZNS = p_s$ and taking p from Tables VII and VI, as shown on page 21, the next step is to compute the local hour angle of Polaris, that is h. It may be obtained in the following manner.

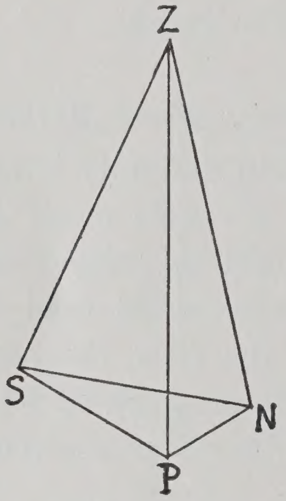

FIG. 12

Suppose p to be less than 180°. Then in the triangle ZPN, $ZNP = p$, $PN =$ polar distance of Polaris, and $PZ = 90^\circ - \varphi$. The problem is to find h, which equals $360^\circ - ZPN$.

In any spherical triangle ABC,

$$\cot a \sin b = \cot A \sin C + \cos b \cos C$$

Applying this formula to the triangle NZP,

$$\cot PZ \sin PN = \cot ZNP \sin ZPN + \cos PN \cos ZPN$$

$$\tan \varphi \cos d = \cot p \sin (360^\circ - h) + \sin d \cos (360^\circ - h)$$

$$= - \cot p \sin h + \sin d \cos h \qquad (1)$$

In the above proof, it has been assumed that p is less than 180°. If p is greater than 180°, the same result is obtained. This case is represented

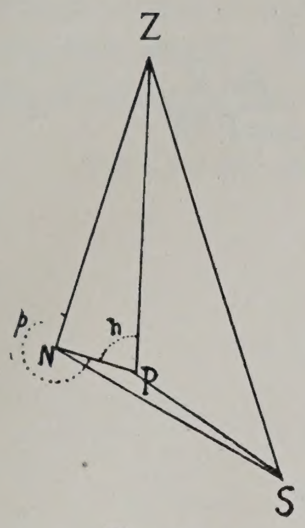

FIG. 13

by fig. 13, in which, as before

$$\cot PZ \sin PN = \cot ZNP \sin ZPN + \cos PN \cos ZPN$$

$$\tan \varphi \cos d = \cot (360° - p) \sin h + \sin d \cos h$$

$$= - \cot p \sin h + \sin d \cos h$$

This is the same equation as (1).

Where p is greater than 180°, it is sometimes simpler to measure it clockwise and call it negative. Thus in fig. 13, instead of $\cot p$, we may write $\cot (-ZNP)$; for

$$\cot p = \cot (360° - ZNP) = - \cot ZNP = \cot (-ZNP).$$

See Table V, page 70.

§ 15. *Effect upon hour angle of Errors in Latitude and in Position Angle.*

(1) Effect upon h of error in φ:

In the equation

$$\tan \varphi \cos d = - \cot p \sin h + \sin d \cos h$$

it is important to know the effect produced upon h (which represents the longitude) by an error in φ. Differentiating, φ and h being the variables,

$$\sec^2 \varphi d\varphi \cos d = - \cot p \cos h dh - \sin d \sin h dh$$

$$\therefore \quad \frac{dh}{d\varphi} = - \frac{\sec^2 \varphi \cos d}{\cot p \cos h + \sin d \sin h}$$

$$= - \frac{\sec^2 \varphi \cos d \sin p}{\cos p \cos h + \sin p \sin h \sin d} \qquad (1)$$

In any spherical triangle ABC,

$$\cos A = - \cos B \cos C + \sin B \sin C \cos a$$

Applying this formula to the triangle ZPN, fig. 12,

$$\cos PZN = - \cos ZNP \cos NPZ + \sin ZNP \sin NPZ \cos PN.$$

But

$$NPZ = 360° - h$$

$$\therefore \quad \cos PZN = - \cos p \cos h - \sin p \sin h \sin d$$

$$- \cos PZN = \cos p \cos h + \sin p \sin h \sin d$$

Substituting in (1),

$$\frac{dh}{d\varphi}=\frac{\sec^2\varphi\cos d\sin p}{\cos PZN}=\sec\varphi\,.\,\frac{\sin p}{\cos\varphi}\cdot\frac{\cos d}{\cos PZN}$$

But in the triangle *PNZ*,

$$\frac{\sin PNZ}{\sin PZ}=\frac{\sin PZN}{\sin PN}$$

$$\therefore\qquad \frac{\sin p}{\cos\varphi}=\frac{\sin PZN}{\cos d}$$

$$\therefore\qquad \frac{dh}{d\varphi}=\sec\varphi\,.\,\frac{\sin PZN}{\cos d}\,\frac{\cos d}{\cos PZN}$$

$$=\tan PZN\sec\varphi \tag{2}$$

It has been shown above (page 20) that in the temperate zone, the maximum value of *PZN* is 2° 45′.4. Hence the greatest possible value of $dh/d\varphi$ in the temperate zone (in which φ never exceeds 66° 33′), is

$$\frac{dh}{d\varphi}=\tan\,(2^\circ\;45'.4)\;\sec\,(66^\circ\;33')$$

$$=.121$$

This means that, in the temperate zone, the error in the longitude, corresponding to a given error in the latitude, is never more than 12 per cent. of the latter, and amounts to this only in places near the arctic circle, and only when *PZN* has its maximum value of 2° 45′.4. Even there, *PZN* may be zero, making $dh/d\varphi$ also zero.

In places farther south, *PZN* has a smaller value. For instance, in latitude 45°,

$$\sin PZN=\frac{\cos d}{\cos\varphi}=\cos\,(88^\circ\;54'.2)\;\sec 45^\circ$$

$$\therefore\qquad PZN=1^\circ\;33'$$

and

$$\frac{dh}{d\varphi}=\tan\,(1^\circ\;33')\;\sec 45^\circ=.038$$

The conclusion is that an error in the latitude has but little effect upon the longitude.

(2) Effect upon h of an error in p:

In the hour angle equation

$$\tan\varphi\cos d=-\cot p\sin h+\sin d\cos h$$

the effect produced upon h (which represents the longitude) by an error in the position angle p is shown as follows:
Differentiating, p and h being the variables,

$$0 = \operatorname{cosec}^2 p dp \sin h - \cot p \cos h dh - \sin d \sin h dh \, .$$

$$\therefore \quad \frac{dh}{dp} = \frac{\operatorname{cosec}^2 p \sin h}{\cot p \cos h + \sin d \sin h}$$

$$= \frac{\operatorname{cosec}^2 p \sin h \sin p}{\cos p \cos h + \sin p \sin h \sin d}$$

$$= \frac{\operatorname{cosec} p \sin h}{\cos p \cos h + \sin p \sin h \sin d} \qquad (3)$$

In any spherical triangle ABC,

$$\cos A = - \cos B \cos C + \sin B \sin C \cos a$$

Applying this formula to the triangle ZNP,

$$\cos PZN = - \cos ZNP \cos NPZ + \sin ZNP \sin NPZ \cos PN$$

But

$$NPZ = 360° - h$$

$$\therefore \quad \cos PZN = - \cos p \cos h - \sin p \sin h \sin d$$

$$- \cos PZN = \cos p \cos h + \sin p \sin h \sin d$$

Substituting in (3),

$$\frac{dh}{dp} = - \frac{\operatorname{cosec} p \sin h}{\cos PZN} = - \frac{\sin h}{\sin p \cos PZN}$$

$$= - \frac{\sin h}{\sin p} \sec PZN$$

In triangle PZN, fig. 12, page 28,

$$\frac{\sin NPZ}{\sin ZNP} = \frac{\sin NZ}{\sin PZ}$$

$$- \frac{\sin h}{\sin p} = \frac{\cos a}{\cos \varphi}$$

$$\therefore \quad \frac{dh}{dp} = \frac{\cos a}{\cos \varphi} \sec PZN$$

Since a differs from φ only by about a degree at most, the ratio $\cos a / \cos \varphi$ is nearly unity. Hence

$$\frac{dh}{dp} = \sec PZN \text{ (nearly)}$$

As PZN varies from 0 to its maximum value of 2° 45′.4, dh is approximately equal to dp; in other words, an error in the position angle is reproduced to the same extent (and no more) in the longitude.

§ 16. *Rigid Solution of Hour Angle Equation.*

Taking the equation for the hour angle,

$$\tan\varphi \cos d = \sin d \cos h - \cot p \sin h$$

and dividing by $\sin d$, we get

$$\tan\varphi \cot d = \cos h - \frac{\cot p \sin h}{\sin d}$$

Putting

$$\frac{\cot p}{\sin d} = \cot\vartheta = \frac{\cos\vartheta}{\sin\vartheta}$$

$$\tan\varphi \cot d = \cos h - \frac{\cos\vartheta \sin h}{\sin\vartheta}$$

$$= \frac{\sin(\vartheta - h)}{\sin\vartheta}$$

$$\therefore \qquad \sin(\vartheta - h) = \sin\vartheta \tan\varphi \cot d$$

where

$$\tan\vartheta = \tan p \sin d$$

The last two equations determine h.

§ 17. *Approximate Solution of Hour Angle Equation.*

The foregoing solution of the hour angle equation is exact; but for use in navigation we may employ an approximate solution, which is much more simple and at the same time is ample for all practical purposes.

The hour angle equation is

$$\tan\varphi \cos d = -\cot p \sin h + \sin d \cos h.$$

The angles h and p are so related that the difference between them ($h - p$ or $p - h$, as the case may be) never varies much from 180°. In fig. 14, in which the small portion of sky around the pole P is considered as a plane, and p is larger than h,

$$p - h = p - ZPN = p - PNL = ZNL = 180° + ZNZ'.$$

And in fig. 15, where h is larger than p,

$$\begin{aligned} h - p &= h - PNZ = h - (PNZ' - ZNZ') \\ &= h - PNZ' + ZNZ' = h - NPS + ZNZ' \\ &= 180° + ZNZ' \end{aligned}$$

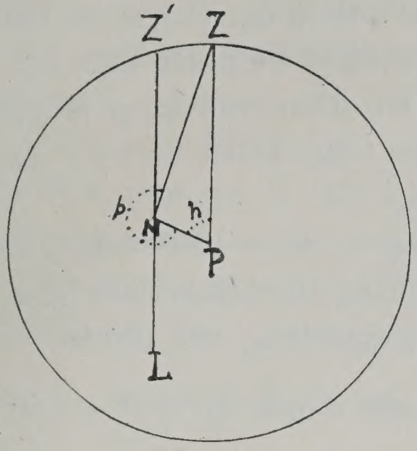

Fig. 14

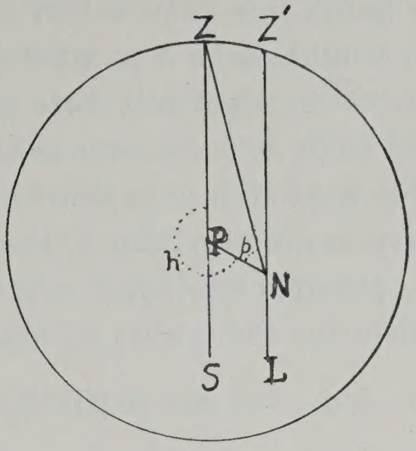

Fig. 15

Hence, in all cases, $p \sim h$ exceeds 180° by the small angle ZNZ', which we shall call ϑ. The smallest value of ϑ occurs when N is on the meridian, in which case ϑ is zero, and $p \sim h = 180°$. The largest value of ϑ occurs where PN is at right angles to NZ. In that case (fig. 14)

$$\sin PN = \sin PZN \sin PZ$$

$$\cos d = \sin \vartheta \cos \varphi, \text{ or } \sin \vartheta = \frac{\cos d}{\cos \varphi}$$

In the temperate zone, the maximum value of φ is 66° 33′; and $d =$ 88° 54′.2 (for the year 1925). These values give for ϑ a maximum value of 2° 45′.4 in the temperate zone. Thus

$$p \sim h = 180° + \vartheta, \text{ where } \vartheta \text{ varies from } 0° \text{ to } 2° \; 45'.4$$

Where p is greater than h, the equation is $p - h = 180° + \vartheta$. Where p is less than h, the equation is $h - p = 180° + \vartheta$. Or generally, $p - h = \pm (180° + \vartheta)$, taking the plus or minus sign according as p is greater or less than h.

In practice, p is determined first by calculation. As soon as p is known, we can decide at once whether it is greater or less than h; for inspection of figs. 14 and 15 shows that, where p is greater than 180°, it is greater than h; and where p is less than 180°, it is less than h. The same result may be reached a little differently by considering the two possible equations connecting h and p, namely,

$$p = h + 180° + \vartheta \qquad (1)$$

$$h = p + 180° + \vartheta \qquad (2)$$

If then p is known, and is less than 180°, eq. (1) is impossible, and we must take eq. (2), which shows that in this case p is less than h. If, on the other hand, p is known, and is greater than 180°, then eq. (2) is impossible, for it would make h greater than 360° (24^h); hence we must take eq. (1), which shows that p is here greater than h. In other words, p is greater or less than h, according as it is greater or less than 180°.

The next step is to show how ϑ is computed.

If p is greater than h, then from (1), $h = p - \vartheta - 180°$. If p is less than h, then from (2), $h = p + \vartheta + 180°$. Taking the latter case first, and substituting this value of h in the hour angle equation, we obtain

$$\begin{aligned}\tan \varphi \cos d &= -\cot p \sin (p + \vartheta + 180°) + \sin d \cos (p + \vartheta + 180°)\\ &= \cot p \sin (p + \vartheta) - \sin d \cos (p + \vartheta)\\ &= \cot p \sin p \cos \vartheta + \cot p \cos p \sin \vartheta - \sin d \cos (p + \vartheta)\\ &= \cos p \cos \vartheta + \frac{\cos^2 p}{\sin p} \sin \vartheta - \sin d \cos (p + \vartheta)\end{aligned}$$

Now $d = 88° 54' 11''.12$, and $\sin d = .9998167 = 1 - .0001833$.

$$\begin{aligned}\therefore \qquad \tan \varphi \cos d &= \cos p \cos \vartheta + \frac{\cos^2 p}{\sin p} \sin \vartheta\\ &\qquad - \cos (p + \vartheta) + .0001833 \cos (p + \vartheta)\\ &= \cos p \cos \vartheta + \frac{\cos^2 p}{\sin p} \sin \vartheta - \cos p \cos \vartheta\\ &\qquad + \sin p \sin \vartheta + .0001833 \cos (p + \vartheta)\\ &= \frac{\cos^2 p \sin \vartheta}{\sin p} + \frac{\sin^2 p \sin \vartheta}{\sin p} + .0001833 \cos (p + \vartheta)\\ &= \frac{\sin \vartheta}{\sin p} + .0001833 \cos (p + \vartheta)\end{aligned}$$

$$\begin{aligned}\therefore \qquad \sin \vartheta &= \sin p \tan \varphi \cos d - .0001833 \sin p \cos (p + \vartheta)\\ &= \sin p \tan \varphi \cos d - .0001833 \sin p \cos p \cos \vartheta\\ &\qquad + .0001833 \sin^2 p \sin \vartheta \qquad (3)\end{aligned}$$

Since ϑ is small (not greater than 2° 45'.4 in the temperate zone), its value in radian measure is not over .04811, and is practically equal to its sine, which is not over .04807. Hence ϑ may be substituted for $\sin \vartheta$ and eq. (3) will give for the value of ϑ three terms, of which the one written last ($.0001833 \sin^2 p \sin \vartheta$) has for its greatest value (occurring when $p = 90°$ and $\vartheta = 2° 45'.4$)

$$.0001833 \sin (2° 45'.4) = 1''.82 \text{ (in radian measure).}$$

This term is, therefore, so small as to be negligible.

The next preceding term in eq. (3) is .0001833 sin p cos p cos ϑ, which may be written .00009165 sin $2p$ cos ϑ. This term is a maximum when sin $2p = 1$ and cos $\vartheta = 1$ (or $\vartheta = 0$), becoming then .00009165, which is the radian measure for 18″.90. This is for the smallest value of ϑ. The largest value of ϑ, namely, 2° 45′.4, makes the value of the term 18″.88, or practically the same as before. Hence all the values of ϑ produce the same effect upon the term as $\vartheta = 0$, and therefore we take this value and write the term .00009165 sin $2p$. Accordingly, eq. (3) becomes

$$\vartheta \text{ (or } \sin \vartheta) = \sin p \tan \varphi \cos d - .00009165 \sin 2p \tag{4}$$

This is the final equation for finding ϑ, and consequently $h - p$, which $= 180° + \vartheta$. Of the two terms on the right hand side of the equation, the first may be called ϑ_1 and the second ϑ_2. Thus $\vartheta = \vartheta_1 - \vartheta_2$, where $\vartheta_1 = \sin p \tan \varphi \cos d$, and $\vartheta_2 = .00009165 \sin 2p$.

The above discussion applies to the case where p is less than h. If p is greater than h, then $h = p - \vartheta - 180°$. Pursuing the same process as before,

$$\vartheta \text{ (or } \sin \vartheta) = - \sin p \tan \varphi \cos d + .00009165 \sin 2p \tag{5}$$

In this last case, p, being greater than h, is greater than 180°, and its sine is minus. This causes the first term (ϑ_1) in the value of ϑ (or sin ϑ) given by (4) and (5) to be always positive. The sign of the second term (ϑ_2) varies as p increases through the four quadrants; in the first and fourth quadrants the term is negative, while in the second and third quadrants it is positive. The values of ϑ_2 for the successive values of p are tabulated in Table IV. Since, however, the term never attains a higher magnitude than 18″.9, the practical navigator will be content in most cases to ignore it.

To sum up the formulae for ϑ,

$$\vartheta = \vartheta_1 + \vartheta_2$$

where ϑ_1 (or sin ϑ_1) $= \sin p \tan \varphi \cos d$, and ϑ_2 is taken (if desired) from Table IV.

In computing the latitude, the formula $\sin a_1 = \cos p \cos d$ was used. Hence it will tend to brevity to write

$$\begin{aligned} \vartheta_1 \text{ (or } \sin \vartheta_1) &= \sin p \tan \varphi \cos d = \sin p \tan \varphi \cos d \cos p / \cos p \\ &= \sin a_1 \tan p \tan \varphi \end{aligned} \tag{6}$$

in which sin a_1, already obtained, can be used.

§ 18. *Complete Formula for Longitude.*

We have seen (page 27) that Long. $= H - h$, where $H =$ G.C.T + Corr. + (sid. time of 0^h G.C.T.) $- RAN$.

In the preceding section, it has been shown that if p is larger than h, $h = p - (180^\circ + \vartheta)$, and if p is smaller than h, $h = p + (180^\circ + \vartheta)$.

If then $p > h$, the formula for longitude becomes

$$\begin{aligned}\text{Long.} &= H - h \\ &= \text{G.C.T.} + \text{Corr.} + (\text{sid. time of } 0^h \text{ G.C.T.}) \\ &\qquad - RAN - p + 180^\circ + \vartheta. \\ &= \text{G.C.T.} + \text{Corr.} + (\text{sid. time of } 0^h \text{ G.C.T.}) \\ &\qquad + 180^\circ - (RAN + n + p_s) + \vartheta\end{aligned}$$

since $p = p_s + n$.

If, on the other hand, $p < h$, the formula becomes,

$$\begin{aligned}\text{Long.} &= H - h \\ &= \text{G.C.T.} + \text{Corr.} + (\text{sid. time of } 0^h \text{ G.C.T.}) \\ &\qquad - RAN - p - 180^\circ - \vartheta\end{aligned}$$

Adding 360° to this value of the longitude (which does not alter its value),

$$\begin{aligned}\text{Long.} &= \text{G.C.T.} + \text{Corr.} + (\text{sid. time of } 0^h \text{ G.C.T.}) \\ &\qquad + 180^\circ - (RAN + n + p_s) - \vartheta.\end{aligned}$$

These values for the longitude are the same, except as to the sign of ϑ, which is plus if $p > h$, *i.e.*, if $p > 180^\circ$, and minus if $p < h$, *i.e.*, if $p < 180^\circ$.

The above is our complete formula for longitude.

It has been shown how n is computed, and it has been pointed out that n varies rapidly from day to day, but varies in the opposite sense to RAN, so that $RAN + n$ is almost constant. For this reason, $RAN + n$ has been chosen as the quantity to be tabulated in the star table (Table VII). From this table the value of $RAN + n$ may be taken for any desired day by simple inspection. By subtracting from this value the value of RAN as given in Table VI, n may be obtained.

As an illustration, let the previous example be taken, and suppose that on the Greenwich date, Aug. 6, 1925, at G.C.T. $3^h\ 36^m\ 30^s$ A.M., the altitude of Polaris is found to be 33° 20′, and the altitude of Vega (which is in the west) is 64° 38′. The values $p_s = 30^\circ\ 49'.5$, $p = 104^\circ\ 50'.2$, and $\varphi = 33^\circ\ 2'.7$ have previously been found (page 22).

The equation is

$$\sin \vartheta_1 = \sin a_1 \tan p \tan \varphi$$

$\sin a_1$		7.6920(*n*)
$\tan p$		.5769(*n*)
$\tan \varphi$		9.8132
$\sin \vartheta_1$	0° 41′.5	8.0821
ϑ_2	+ ′.2	
ϑ	0° 41′.7	

	h	m	s
G.C.T.	3	36	30
Corr.			35.5
Sid. time of 0^h G.C.T.	20	56	2.8
	24	33	8.3
		8°	17′.0
		180°	
		188°	17′.0
$RAN + n + p_s$		—128°	35′.3
		59°	41′.7
ϑ			—41′.7
W. Long.		59°	0′.0

§ 19. *Given the longitude, to find the position angle.*

The usual problem is, Given the position angle, to find the longitude. But the converse question occasionally arises, and it may be answered either by the solution of a spherical triangle, or approximately and far more briefly, as follows:

The equation for longitude is, $\text{Long.} = H - h$.

(1) If $h < p$, then

$$\begin{aligned} p - h &= 180° + \vartheta \\ &= 180° - \cos d \sin p \tan \varphi \\ &= 180° - e \sin p, \text{ where } e = \cos d \tan \varphi \end{aligned}$$

$$\therefore -h = 180° - p - e \sin p$$

$$\therefore \text{Long.} = H + 180° - p - e \sin p$$

$$\therefore \quad p = H - \text{Long.} + 180° - e \sin p$$

$$\therefore \quad p = m - e \sin p, \text{ where } m = H - \text{Long.} + 180° = h + 180°, \text{ and}$$

$$e = \cos d \tan \varphi$$

Developing this equation ($p = m - e \sin p$) by Lagrange's Theorem, we get

$$\begin{aligned} p &= m - e \sin m + \frac{e^2}{2} \sin 2\,m - e^3 \sin m + \frac{3}{2} e^3 \sin^3 m \\ &= m - (e \sin m) + (e \sin m)\ (e \cos m) - (e \sin m)\ e^2 + \frac{3}{2} (\ e \sin m)^3 \\ &= m - (e \sin m) + (e \sin m)\,(e \cos m) - (e \sin m)\,(e \cos m)^2 + \frac{1}{2} (e \sin m)^3 \end{aligned}$$

The last form is preferable for logarithmic computation.

(2) If $h > p$, then

$$\begin{aligned} h - p &= 180^\circ + \vartheta \\ &= 180^\circ + \cos d \sin p \tan \varphi \\ &= 180^\circ + e \sin p, \text{ where } e = \cos d \tan \varphi \end{aligned}$$

$$\therefore \quad h = 180^\circ + p + e \sin p$$

$$\text{Long.} = H - h = H - 180^\circ - p - e \sin p$$

$$\begin{aligned} p &= H - \text{Long.} - 180^\circ - e \sin p \\ &= m - e \sin p, \text{ where } m = H - \text{Long.} - 180^\circ = h - 180^\circ, \text{ and} \\ & \qquad e = \cos d \tan \varphi \end{aligned}$$

The series for p is the same as before.

As the above method ignores the correction ϑ_2, the result may be in error to the extent of the value of ϑ_2, or about 0′.3 at most.

CHAPTER IV

AZIMUTH OF POLARIS

§ 20. *Equation for Azimuth.*

After finding the latitude and longitude, a very little additional work will suffice to give the azimuth of Polaris. For to find the azimuth PZN (fig. 16), we have

$$\frac{\sin PZN}{\sin PN} = \frac{\sin PNZ}{\sin PZ}$$

$$\sin A_z = \frac{\cos d \sin p}{\cos \varphi} \tag{1}$$

In computing the longitude, we used the equation

$$\sin \vartheta_1 = \cos d \sin p \tan \varphi$$

$$= \frac{\cos d \sin p \sin \varphi}{\cos \varphi}$$

$$= \sin A_z \sin \varphi$$

$$\therefore \qquad \sin A_z = \frac{\sin \vartheta_1}{\sin \varphi} = \sin \vartheta_1 \operatorname{cosec} \varphi \tag{2}$$

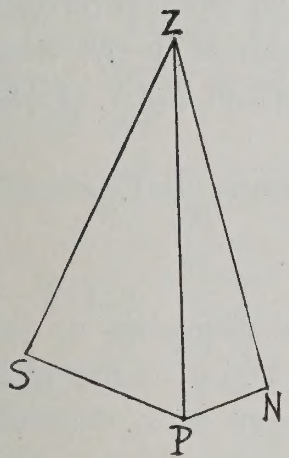

FIG. 16

To determine whether the azimuth is east or west, we may look at the hour angle of Polaris. If this is less than 180°, the azimuth is evidently west; if it is greater than 180°, the azimuth is east. To determine whether the hour angle of Polaris is greater or less than 180°, look at p; for if $p < 180°$, $h > 180°$, and if $p > 180°$, $h < 180°$.

An easterly azimuth is positive and a westerly azimuth is negative; for the sign of $\sin A_z$ (and hence the sign of A_z itself) from eq. (1) depends on the sign of $\sin p$, and $\sin p$ is positive or negative according as p is less or greater than 180°, that is, according as h is greater or less than 180°.

CHAPTER V

RECAPITULATION. EXAMPLES

§ 21. *Summary of Formulae.*

We shall now recapitulate our formulae.

The given quantities are the corrected simultaneous altitudes of the North Star, and of some other star selected for comparison. The comparison star should bear as nearly as possible east or west of the observer.

First compute the position angle (p_s) of the comparison star by means of the formula—

$$\text{hav } p_s = \sec a \operatorname{cosec} c \cos s \sin (s - a_s)$$

where $a =$ alt. of North Star, $a_s =$ alt. of comparison star, $c =$ distance from North Star to comparison star (given, along with log cosec c, in Table VII), and $s = \frac{1}{2}(a_s + a + c)$. This formula gives two values for p_s, since hav $p_s =$ hav $(360° - p_s)$. Take the larger value, if the comparison star is in the east; the smaller value, if the comparison star is in the west.

Add p_s to $RAN + n$ (given in Table VII). Then subtract RAN (given in Table VI). This gives $p_s + n = p$.

We are now in a position to find the latitude, longitude and azimuth of Polaris.

To find the latitude (φ):

$\varphi = a + a_1 - a_2$, where $a =$ alt. of North Star, a_1 is given by a_1 (or $\sin a_1) = \cos p \cos d$ ($\cos d$ being taken from Table VI), and a_2 is taken, if desired, from Table III, but is usually negligible. The sign of a_1 depends upon the sign of $\cos p$, and hence is plus where p is between 0° and 90°, or 270° and 360°, and minus where p is between 90° and 270°.

To find the longitude:

First find ϑ from the equation $\vartheta = \vartheta_1 + \vartheta_2$, where ϑ_1 (or $\sin \vartheta_1) = \sin a_1 \tan p \tan \varphi$, and ϑ_2, which is usually negligible, may, if great accuracy is desired, be taken with its proper sign from Table IV. [Note that the sign of ϑ_2 is always opposite to the sign of a_1.] Then

$$\text{Long.} = \text{G. C. T.} + \text{Corr.} + \text{sid. time of } 0^h \text{ G. C. T.} + 180° - (RAN + n + p_s) \pm \vartheta$$

The plus or minus sign is used according as p is greater or less than 180°.

G. C. T. is the Greenwich civil time of the observation, commencing at midnight and measured up to 24 hours.

Corr. is the correction to reduce mean solar time to sidereal time. See Amer. Naut. Alm. (1925), page 110.

Sid. time of 0^h G.C.T. is given in Table VI.

$RAN + n$ is given in Table VII for a series of 27 comparison stars.

§ 22. *Examples.*

We shall now repeat the two examples which have already been worked in instalments, in order to show how the work may be arranged as a whole.

Ex. 1. Given—

Alt. of Polaris, 33° 20′.
" " Vega, 64° 38′. Vega is in the west.
Greenwich civil time, $3^h\ 36^m\ 30^s$ A. M., Aug. 6, 1925.
Find lat., long., and azimuth of Polaris.

Arrange a scheme of the work, as follows (in which the quantities on the right hand side of the page are the successive terms of the longitude equation).

From Table VII take the following quantities, and insert them in the scheme: $c = 51°\ 34'.7$, log cosec $c = .10598$, $RAN + n = 97°\ 45'.8$.

From Table VI take the following quantities, and insert them in the scheme: $RAN = 23°\ 45'.1$, log cos $d = 8.2836$, sid. time of 0^h G. C. T. $= 20^h\ 56^m\ 2^s.8$.

a_s	64° 38′.				h m s
a	33° 20′.	sec a	.07806	G. C. T.	3 36 30.0
c	51° 34′.7	cosec c	.10598	Corr.	35.5
	2)148° 92′.7			Sid. time 0^h G.C.T.	20 56 2.8
s	74° 46′.3	cos s	9.41940		24 33 8.3
$s - a_s$	10° 8′.3	sin $(s - a_s)$	9.24557		
		hav p_s	8.84901		8° 17′.0
		p_s	30° 49′.5		+180°
		$RAN + n$	97° 45′.8		188° 17′.0
		$RAN + n + p_s$	128° 35′.3		−128° 35′.3
		RAN	23° 45′.1		59° 41′.7
		$p = n + p_s$	104° 50′.2		
		cos p	9.4083 (n)		
a	33° 20′.	cos d	8.2836		
a_1	— 16′.9	sin a_1	7.6919 (n)		
$a + a_1$	33° 3′.1				
a_2	—′.4				
φ	33° 2′.7	tan φ	9.8132		
		tan p	.5770 (n)		
		sin ϑ_1	8.0821	ϑ_1	41′.5
		cosec φ	.2634	ϑ_2	′.2
		sin A_z	8.3455	ϑ 41′.7	— 41′.7
		A_z	1° 16′.2	W. Long.	59° 0′.0

The foregoing example is the same as the one on page 685 of the Amer. Ephemeris (1925). The results agree to a second; but, in general, the method above set forth cannot give a higher degree of accuracy than 6″, since it does not employ any smaller angle than 0′.1. However, one-tenth of a minute on the earth is scarcely more than the length of a modern steamship.

If the computer is in a hurry, and does not care for a minutely accurate result, he may use four-figure and three-figure logarithms, respectively, and omit the small corrections a_2 and ϑ_2. Proceeding in this way in the above example, he will obtain lat. = 33° 3′.1, and long. = 58° 59′.9.

The reader may inquire whether an error is not likely to arise from determining $p = n + p_s$ by subtracting RAN from $RAN + n + p_s$, where we use, for all hours of the day, the value of RAN which is given in Table VI, this value being computed for the upper transit of the North Star at Greenwich. It is true that the value of RAN for some other hour of the day may differ from this tabulated value by as much as 0′.3 or a little more; and to this extent the value of p may be in error. But this will not affect substantially either the latitude or the longitude; for, as regards the latitude, it is shown in § 8 (page 19) that errors in p have but little effect upon latitude; and, as regards longitude, we do not employ p as a separate term, but only in the combination $RAN + p = RAN + n + p_s$, where p_s is precisely computed, and $RAN + n$ is constant for any short period, such as a day.

In the computation for azimuth, we have used cosec φ, with a view to employing a uniform system all the way through, namely, adding all quantities. It would have been equally allowable to use sin φ, and subtract. The result for azimuth (1° 16′.2) is positive, *i.e.*, the azimuth is easterly. This is also shown by p, which, being less than 180°, indicates that h is greater than 180°; and so, the local hour angle of Polaris being greater than 180°, Polaris is necessarily east of the meridian.

Ex. 2. Given—

Alt. of Polaris, 39° 46′.
" " Altair (in the east), 29° 55′.8.
G. C. T., $3^h\ 36^m\ 30^s$ A. M., June 11, 1925.
Find lat., long., and azimuth of Polaris.

From Table VII enter in the scheme of the work the following quantities: $c = 81° 16'.1$, log cosec $c = .00506$, $RAN + n = 116° 37'.2$.

From Table VI enter in the scheme the following: $RAN = 23° 29'.9$, log cos $d = 8.2838$, sid. time of 0^h G. C.T. $= 17^h\ 15^m\ 15.^s7$.

a_s	29° 55′.8
a	39° 46′.
c	81° 16′.1
	2)150° 57′.9
s	75° 28′.9
$s - a_s$	45° 33′.1

sec a	.11427
cosec c	.00506
cos s	9.39914
sin $(s - a_s)$	9.85362
hav p_s	9.37209
	58° 4′.2
p_s	301° 55′.8
$RAN + n$	116° 37′.2
$RAN + n + p_s$	58° 33′.0
RAN	23° 29′.9
$p = n + p_s$	35° 3′.1

	h	m	s
G. C. T.	3	36	30
Corr.			35.5
Sid. time 0^h G.C.T.	17	15	15.7
	20	52	21.2
	313°	5′.3	
	+ 180°		
	493°	5′.3	
	— 58°	33′.0	
	434°	32′.3	

a	39° 46′.
a_1	54′.1
$a + a_1$	40° 40′.1
a_2	—′.1
φ	40° 40′.0

cos p	9.9131
cos d	8.2838
sin a_1	8.1969
tan φ	9.9341
tan p	9.8460
sin ϑ_1	7.9770
cosec φ	.1860
sin A_z	8.1630
A_z	0° 50′.0

ϑ_1	32′.6
ϑ_2	—′.3
ϑ	32′.3

	—	32′.3
	434°	0′.0
	360°	
W. Long.	74°	0′.0

The above is the same example as that on page 106 of Amer. Naut. Alm. (1925). The Nautical Almanac table on the page just cited gives, by an exact interpolation, 40° 39′ 41″ for the latitude. The more extended table in Amer. Ephem. (1925), page 685, makes the latitude 40° 39′ 55″. A precise solution of the astronomical triangle involved in the problem, with the use of seven-figure logarithms, gives the latitude as 40° 39′ 55″.6. Thus our result (40° 40′) is only 4″.4 in error.

If four-figure and three-figure logarithms are employed, and the corrections a_2 and ϑ_2 omitted, the results are lat. = 40° 40′.1, long. = 73° 59′.9.

Ex. 3. On board an airship somewhere over the Atlantic Ocean, about 9 P. M. local time (mean solar), March 21, 1925. With Lucy's Metrangle, the altitude of Polaris is found to be 44° 36′, and of Procyon, 46° 40′. Procyon is in the west. A wireless message gives the Greenwich civil time as $1^h\ 20^m\ 30^s$ A. M., the Greenwich date being March 22, 1925. What are the latitude and longitude?

From Table VII, $c = 84°\ 35'.7$, log cosec $c = .00193$, $RAN + n = 293°\ 57'.0$.

From Table VI, $RAN = 23°\ 22'.3$, log cos $d = 8.2816$, sid. time of 0^h G. C. T. $= 11^h\ 55^m\ 54.8^s$.

a_s	46° 40′				h m s
a	44° 36′	sec a	.1475	G. C. T.	1 20 30
c	84° 36′	cosec c	.0019	Corr.	13.2
2)	174° 112′			Sid. time 0^h G. C. T.	11 55 54.8
s	87° 56′	cos s	8.5571		13 16 38.0
$s - a_s$	41° 16′	sin $(s - a_s)$	9.8193		
		hav p_s	8.5258		199° 9′.5
		p_s	21° 7′		+ 180°
		$RAN + n$	293° 57′		379° 9′.5
		$RAN + n + p_s$	315° 4′		− 315° 4′.
		RAN	23° 22′		64° 5′.5
		$p = n + p_s$	291° 42′		

		cos p	9.568		
a	44° 36′.0	cos d	8.282		
a_1	0° 24′.3	sin a_1	7.850		
φ	45° 0′.3	tan φ	0.000		
		tan p	.400		
		sin ϑ_1	8.250	ϑ_1 1° 1′.1	+ 1° 1′.1
				W. Long.	65° 6′.6

Ex. 4. On board a ship in the Mediterranean. Alt. of Polaris, 37° 1′. Alt. of Rigel (in the east), 29° 45′. The Greenwich date is Dec. 26, 1925. G. C. T., 18^h 48^m 10^s. Find lat. and long.

From Table VII, $c = 97°\ 38'.8$, log cosec $c = .00388$, $RAN + n = 257°\ 37'.4$.

From Table VI, $RAN = 23°\ 48'.4$, log cos $d = 8.2787$, sid. time of 0^h G. C. T. $= 6^h\ 15^m\ 53.^s6$.

a_s	29° 45′				h m s
a	37° 1′	sec a	.0977	G. C. T.	18 48 10
c	97° 39′	cosec c	.0039	Corr.	3 5.3
2)	164° 25′			Sid. time 0^h G.C.T.	6 15 53.6
s	82° 12′	cos s	9.1326		25 7 8.9
$s - a_s$	52° 27′	sin $(s - a_s)$	9.8992		
		hav p_s	9.1334		
		p_s	43° 16′		376° 47′.2
			316° 44′		+ 180°
		$RAN + n$	257° 37′		556° 47′.2
		$RAN + n + p_s$	574° 21′		
			360°		
			214° 21′		− 214° 21′.
		RAN	23° 48′		342° 26′.2
		$p = n + p_s$	190° 33′		

		cos p	9.993 (n)		
a	37° 1′.	cos d	8.279		
a_1	− 1° 4′.3	sin a_1	8.272 (n)		
φ	35° 56′.7	tan φ	9.860		
		tan p	9.270		
		sin ϑ_1	7.402	ϑ_1 0° 8′.7	+ 8′.7
				W. Long.	342° 34′.9
				E. "	17° 25′.1

Ex. 5. On board a ship in the Indian Ocean, at a time which at Greenwich is G. C. T. $17^h\ 40^m\ 10^s$, Sept. 8, 1925, the alt. of Polaris is 20° 26′, and of Markab (in the east), 62° 48′. Find lat. and long.

From Table VII, $c = 74°\ 20'.2$, log cosec c = .01643, $RAN + n =$ 165° 4′.8.

From Table VI, RAN = 23° 52′.6, log cos d = 8.2827, sid. time of 0^h G. C. T. = $23^h\ 6^m\ 9^s.1$.

a_s	62° 48′					h m s
a	20° 26′	sec a	.0282		G.C.T.	17 40 10
c	74° 20′	cosec c	.0164		Corr.	2 54.1
2)	156° 94′				Sid. time 0^h G.C.T.	23 6 9.1
s	78° 47′	cos s	9.2890			40 49 13.2
$s - a_s$	15° 59′	sin $(s - a_s)$	9.4399			24
		hav p_s	8.7735			16 49 13.2

	28° 12′		
p_s	331° 48′		
$RAN + n$	165° 5′		252° 18′.3
	496° 53′	+	180°
	360°		432° 18′.3
$RAN + n + p_s$	136° 53′	−	136° 53′
RAN	23° 53′		295° 25′.3
$p = n + p_s$	113° 00′		

		cos p	9.592(n)		
a	20° 26′	cos d	8.283		
a_1	−25′.8	sin a_1	7.875(n)		
φ	20° 0′.2	tan φ	9.561		
		tan p	.372(n)		
		sin ϑ_1	7.808	ϑ_1 0°22′.1	−22′.1
				W. Long.	295° 3′.2
				E. Long.	64° 56′.8

Ex. 6. A party of shipwrecked sailors are on an ice floe in the Arctic Ocean. One of them has a watch regulated to Greenwich time, which gives G. C. T. = $21^h\ 40^m\ 10^s$. The Greenwich date is Aug. 29, 1925. With an Abney's level, saved from the wreck, the altitude of Polaris is found to be 68° 14′, and of Beta Cassiopeiae, which is in the east, 65° 10′. They have no compass. Find the latitude, the longitude, and the north point.

From Table VII, c = 30° 15′, log cosec c = .29776, $RAN + n$ = 180° 35′.3.

From Table VI, RAN = 23° 50′.7, log cos d = 8.2831, sid. time of 0^h G.C.T. = $22^h\ 26^m\ 43.^s6$.

a_s	65° 10′						h m s
a	68° 14′	sec a	.4308			G.C.T.	21 40 10
c	30° 15′	cosec c	.2978			Corr.	3 33.6
2)	163° 39′					Sid. time 0^h G.C.T.	22 26 43.6
s	81° 49′.5	cos s	9.1529				44 10 27.2
$s - a_s$	16° 39′.5	sin $(s - a_s)$	9.4574				24
		hav p_s	9.3389				20 10 27.2
			55° 42′				302° 36′.8
		p_s	304° 18′				+ 180°
		$RAN + n$	180° 35′				482° 36′.8
			484° 53′				
			360°				
		$RAN + n + p_s$	124° 53′				− 124° 53′.0
		RAN	23° 51′				357° 43′.8
		$p = n + p_s$	101° 2′				
		cos p	9.282(n)				
a	68° 14′.0	cos d	8.283				
a_1	— 12′.6	sin a_1	7.565(n)				
$a + a_1$	68° 1′.4						
a_2	— 1′.5						
φ	67° 59′.9	tan φ	.394				
		tan p	.710(n)				
		sin ϑ_1	8.669	ϑ_1	2° 40′.5		
		cosec φ	.033	ϑ_2	+ ′.1		
		sin A_z	8.702	ϑ	2° 40′.6		— 2° 40′.6
		A_z	2° 53′.2			W. Long.	355° 3′.2
						E. Long.	4° 56′.8

§ 23. *General Remarks.*

(1) In all these calculations, the starting point is the Greenwich date and hour. The Greenwich hour is given by the chronometer, or by wireless. The Greenwich date is often a day ahead of the local date, or a day behind it. The Greenwich date fixes one of the principal data, *i.e.,* the sidereal time at which the Greenwich civil day begins.

(2) The result arrived at for longitude is considered as measured westwardly from Greenwich all the way around the earth up to 360°. The longitude east of Greenwich can be obtained by a simple subtraction.

(3) An angle is not altered by adding 360° to it, or subtracting 360° from it. If an angle is to be subtracted from a smaller angle, add 360° to the latter, and then make the subtraction. So, if a result comes out larger than 360°, subtract 360° from it.

(4) To convert sidereal time into degrees, Table I may be used; or the work may be done even more quickly in the following way (which the reader can easily verify for himself):

(a) Take the *hours,* annex a cipher, add to this number one-half of itself, and call the result *degrees.*

(b) Take the *minutes,* divide by 4, and call the quotient *degrees.* If a fraction of a degree results from the division, turn it into minutes. The fractions will be ¼, ½, or ¾, and the corresponding minutes will be 15′, 30′, or 45′.

(c) Take the *seconds,* divide by 4, and call this quotient *minutes.*

(d) Add the results.

For example, convert $19^h\ 19^m\ 40.^s8$ into degrees.

$$\begin{array}{rl} 190^\circ & \\ 95^\circ & \\ 4^\circ & 45'. \\ & 10'.2 \\ \hline 289^\circ & 55'.2 = \text{Ans.} \end{array}$$

(5) When entering the tables for cos p, take out at the same time tan p, and write it down at its proper place in the scheme. So also for tan φ and cosec φ.

(6) Use four-figure tables of logarithms, when possible, but not tables so abbreviated as to require interpolation. All interpolation is a check to the current of calculation, and a possible source of error. An excellent book of four-figure logarithms is that of F. G. Gauss (Verlag von Eugen Strien, Halle, Germany). J. T. Bottomley's ''Four Figure Mathematical Tables,'' Macmillan & Co., is also good, as well as very compact.

(7) The chief quantity in the calculation is p. The value of p shows whether ϑ in the longitude formula is additive or subtractive; if p is greater than 180°, ϑ is additive; if p is less than 180°, ϑ is subtractive. Moreover, if p is greater than 180°, h is less than 180°, and Polaris is west of the meridian; if p is less than 180°, h is greater than 180°, and Polaris is east of the meridian. The quantity p is the sole argument in Table IV, for finding ϑ_2, and it is the chief argument in Table III, for finding a_2. Hence the calculations may be said to center around p.

CHAPTER VI.

ADVANTAGES OF USING POSITION ANGLES

§ 24. *In simplicity, convenience, and accuracy.*

The method which has been described above, is a general one, applicable in all situations, so that no exceptions or special cases have to be kept in mind. This diminishes the mental friction of computation and lessens the chance of error. The tables in the appendix, it is believed, will save much labor for the computer, and thus conduce to brevity and accuracy.

The observations for altitude may, in general, be made at any hour of the night when the horizon is visible; and it is not necessary to wait for the particular moment when a heavenly body crosses the meridian or the prime vertical. This point will be particularly appreciated in cold weather. Night observations have the advantage that the sextant is not exposed to the rays of the sun, and hence is less liable to irregular expansions due to heat. So also the temperature of the air is more apt to be uniform at night, and hence refraction errors are less troublesome.

The observations can be made as often as desired, and as they determine azimuth, they render the mariner, so long as the weather remains clear, independent even of his compass. The observations can be worked up at once, without waiting for supplementary data to be supplied by later observations. They give a precise latitude and longitude at a precise time, and so furnish an accurate fixed point for further calculations. The results come out in degrees and minutes of latitude and longitude, and no plotting on a chart is necessary.

§ 25. *In Dispensing with Dead Reckoning.*

In the ordinary practice of navigation, it is not too much to say that, from the beginning of the voyage to the end, the navigator never knows his position accurately. The noon sight determines the latitude; but the longitude depends on a time observation made several hours previously; and since that time the ship has run a distance which is largely guesswork, on a course which can be only roughly measured, and subject to winds and currents of which the effect is unknown. The net outcome, as given by dead reckoning, may be many miles out of the way.

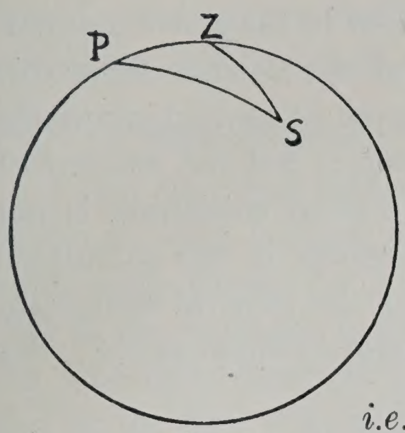

FIG. 17

The percentage of error thus introduced into the longitude by dead reckoning may be estimated in the following way:

In working up a time sight, the navigator assumes the value of the latitude as given by dead reckoning, and solves the equation

$$\cos ZS = \cos PS \cos PZ + \sin PS \sin PZ \cos ZPS$$

$$\textit{i.e.}, \sin a = \cos \Delta \sin \varphi + \sin \Delta \cos \varphi \cos h \qquad (1)$$

where a is the altitude of the observed body, Δ the polar distance of the same, φ the latitude, and h the hour angle. Differentiating (1), φ and h being the variables,

$$0 = \cos \Delta \cos \varphi d\varphi - \sin \Delta \sin \varphi d\varphi \cos h - \sin \Delta \cos \varphi \sin h dh$$

$$\frac{dh}{d\varphi} = \frac{\cos \Delta \cos \varphi - \sin \Delta \sin \varphi \cos h}{\sin \Delta \cos \varphi \sin h} \qquad (2)$$

In any spherical triangle ABC,

$$\sin a \cos B = \cos b \sin c - \sin b \cos c \cos A.$$

Applying this formula to the triangle PZS,

$$\sin ZS \cos PZS = \cos PS \sin PZ - \sin PS \cos PZ \cos ZPS,$$

or

$$\cos a \cos PZS = \cos \Delta \cos \varphi - \sin \Delta \sin \varphi \cos h$$

Substituting in (2),

$$\frac{dh}{d\varphi} = \frac{\cos a \cos PZS}{\sin \Delta \cos \varphi \sin h}$$

But

$$\frac{\sin ZS}{\sin ZPS} = \frac{\sin PS}{\sin PZS}, \text{ or } \frac{\cos a}{\sin h} = \frac{\sin \Delta}{\sin PZS}$$

$$\therefore \quad \frac{dh}{d\varphi} = \frac{\cos PZS}{\sin \Delta \cos \varphi} \, \frac{\sin \Delta}{\sin PZS} = \cot PZS \sec \varphi$$

The values of $dh/d\varphi$ for various values of PZS and φ are given in the following table:

PZS ϕ	90°	80°	70°	60°	50°
30°	0	.20	.42	.67	.97
40°	0	.23	.48	.75	1.10
50°	0	.27	.57	.90	1.31
60°	0	.35	.73	1.15	1.68

It appears, therefore, that where longitude is computed in the above manner, it contains an error which is a definite percentage of the latitude error due to dead reckoning. This *percentage* of error may be computed as in the above table (in which it runs from 0 to 168 per cent.); but the *amount* of the error is always uncertain, because the error in dead reckoning is not known. Hence there is always more or less uncertainty in the calculated longitude of the ship. This is the chief reason for the general complaint among seamen that their forenoon and afternoon sights seldom agree. See Lecky, Wrinkles in Pract. Nav. (19th ed.), page 92.

So also if the seaman uses two altitudes of the sun to give him two intersecting position lines, he is obliged to wait for several hours after the first observation before taking the second, during which time the uncertainties of dead reckoning again come into play.

One of the advantages of the method of this book is that it dispenses altogether with dead reckoning. The place of the ship at the time of observation does not need to be known even approximately. Hence the calculations are free from the errors and uncertainties arising from the necessity of estimating the position reached by a vessel after it has travelled an uncertain distance, in an uncertain direction, blown by uncertain winds, and washed by uncertain currents.

§ 26. *In Facilitating Great Circle Sailing.*

Modern navigation is conducted in large ships, which tend to become larger. Millions of dollars are locked up in ship and cargo. The daily expenditures for fuel, for stores of various kinds, and for the wages of the small army of employees required to man the ship, are enormous. While the voyage is going on, the capital is idle, while the expenses are heavy and continuous. Hence there is a legitimate demand for any facility that will shorten the duration of the voyage. A navigating officer who can bring his vessel to port even a few hours ahead of the average time of the voyage, effects a substantial economy; and when this is multiplied by the number of voyages per year, it becomes a total which can not be ignored.

The mariner who wishes to shorten his voyage, will not only seek the aid of the winds and currents, but will keep his ship, as far as possible, on the arc of a great circle. To do this, he must change his course frequently, and at the time of making the change, must know his latitude and longitude accurately. This, however, he can never do where he is dependent on dead reckoning.

Under the method of this book, the observations can be made as often as desired, when the stars and the horizon are visible. They can be worked up immediately, and will give an accurate point of departure for calculating the next great circle course. Hence the use of this method gives an added facility for great circle sailing.

§ 27. *In Supplementing Time Sights of the Sun.*

From the little table given on page 49, it appears that the farther the observed body is from the prime vertical, the greater is the error in the hour angle caused by a given error in the latitude. From this it results that in the northern hemisphere the sun in winter time is not a good object for longitude observations; for the declination of the sun is then south, and by the time it attains after sunrise an altitude suitable for observation, it is so far from the prime vertical as to be unfavorably situated for time observations. This is especially noteworthy in high latitudes. As an example, assuming that for a favorable time observation the sun should have an altitude of at least 15°, and that an error in the latitude should not be enhanced in the hour angle (*i.e.*, that $dh/d\varphi$ should not be greater than 1), it may easily be shown that in the average latitude of the British Isles (say 55°) there are in the year about 4½ months during which the requisite conditions are not fulfilled, and the sun, in consequence, will not give a good longitude observation. Where the sun is not available, the navigator's only recourse is to fall back upon the stars; and in Table VII he has a list of 27 to select form.

§ 28. *In Utilizing fully the Rate of Rotation of the Earth.*

The method by which latitude and longitude are computed as functions of the position angle of the pole, enables the observer to get all the benefit possible from the rate of the apparent diurnal rotation of the stars. The position angle increases uniformly from 0° to 360° at the same rate at which the earth revolves. This is evident from an inspection of the celestial sphere, and also from the equation $dp/dh = 1$, deduced on page 31. It is obvious that the more rapidly the position angle varies, the more accurate will be the measurement of its value for any given instant of time. Hence in choosing for measurement the position angle, which varies *pari passu* with the rotation of the earth, we have a quantity which can be measured as accurately as the nature of the problem allows.

The case is otherwise with the ordinary method of calculating longitude. There the altitude of a heavenly body is measured when it is on or near the prime vertical. In such a situation the altitude is, it is true, increasing with its maximum rapidity; but, except in very low latitudes, this rapidity is never proportional to the increase in the hour angle; and the greater the latitude, the slower will be the rate of change in the altitude. It is obvious, therefore, that when we deduce the longitude, not from the altitude, which varies slowly, but from the position angle, which varies as rapidly as the rotation of the earth itself, we secure the highest degree of accuracy which is attainable in the nature of the case.

This may be shown mathematically as follows:
Differentiating (1), page 49, a and h being the variables,

$$\begin{aligned} \frac{da}{dh} &= -\frac{\sin\triangle\cos\varphi\sin h}{\cos a} \\ &= -\sin\triangle\cos\varphi\,\frac{\sin PZS}{\sin\triangle},\ \text{since}\ \frac{\sin h}{\cos a} = \frac{\sin PZS}{\sin\triangle} \\ &= -\cos\varphi\sin PZS \qquad (1) \\ &= -\cos\varphi,\ \text{if}\ PZS = 90^\circ. \end{aligned}$$

This equation shows that on the prime vertical, the rate of change in the altitude, correspondent to a given change in the hour angle, is as the cosine of the latitude. For example, in latitude 45°, the altitude rate is only 70 per cent. of the hour angle rate ($\cos 45^\circ = .70$); in latitude 60°, 50 per cent.; in latitude 70°, 34 per cent., etc. On the other hand, since $dp/dh = 1$, the rate of change of the position angle is 100 per cent. of the rate of change of the hour angle, *i.e.*, 100 per cent. of the velocity of rotation of the earth.

§ 29. *As Compared with Sumner Lines of Position.*

The above remarks apply also to Sumner lines of position. To secure the best results from Sumner lines, the two stars observed should differ in azimuth by 90°. Hence if one star is on the prime vertical, where it will give the most accurate position line, the other star should be on the meridian. But as a star approaches the meridian, the triangle which gives the position line, becomes more and more ill-conditioned, and on the meridian itself ceases to exist. Thus from eq. (1), § 28,

$$\frac{dh}{da} = -\frac{1}{\cos\varphi\sin PZS}$$

As the star approaches the meridian, the angle PZS approaches 180°, $\sin PZS$ diminishes, and dh/da increases. On the meridian itself, $PZS = 180^\circ$, $\sin PZS = 0$, and $dh/da = -\infty$.

It follows that if the first star is on the prime vertical and so is favorably situated, the second star is on the meridian and hence is unfavorably situated; and in proportion as the second star moves into a better position, the first star moves into a worse position. Consequently the modern sailor here encounters a dilemma similar to that which confronted his ancient brethren:

Incidit in Scyllam cupiens vitare Charybdim.

In the recent publication of the U. S. Hydrographic Office (Pub. No. 203) on Sumner Lines of Position, it is recommended that for observations near the meridian, the formula $da/dd = \cos S$ be used, where a is the altitude, d the declination, and S the parallactic angle in fig. 17, page 49. [This formula is readily obtained by substituting $90° - d$ for $\triangle$ in eq. (1), § 25, differentiating with a and d as variables, and then making a few simple substitutions.] To apply the formula, it is necessary to obtain the parallactic angle S, either by computation, or by digging it out of the azimuth tables. Either method is tedious and troublesome. In the case of the azimuth tables, it may require in some cases seven interpolations* to get an accurate result; and in all cases it is necessary to make a preliminary transformation of the data before entering the tables. If the computer, without knowing the value of S, boldly assumes that it is so small that $\cos S = 1$, he is liable to make a much larger error than is permissible.

It may be added that while the tables in H. O. Pub. No. 203 save a world of time in obtaining the hour angle and azimuth, there still remains, after those quantities are found, the final task of plotting the results on a chart, or of computing the latitude and longitude of the intersection of the two position lines. Plotting calls for much care and time, if the result is to be accurate; and conditions on shipboard are often unfavorable for plotting.† To compute the point of intersection of the Sumner lines takes even more time. Altogether, it is believed that the method of this book will take less time and produce a more accurate result than the Sumner line method.

It may also be added that the tables in H. O. Pub. No. 203 take no account of stars whose declination exceeds 27°. This excludes the use of many well-known navigational stars, such as Castor, Pollux, Vega, Capella, the stars in the "Dipper," and all or nearly all the stars in Cygnus, Andromeda, Cassiopeia, Perseus, and Draco. All these stars are at times useful to the navigator, and add to his resources.

The work of the Hydrographic Office, just mentioned, has been considered by some authorities as destined to supersede all other methods of navigation. While that work is a monumental production, for which navigators will be forever grateful, it still leaves room, perhaps, for other methods and facilities. Such it is the aim of the present little treatise to supply.

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* To the present writer, interpolations are anathema; and the tables of this book have been so constructed as to make all interpolations (save of the simplest kind) unnecessary.

† In the Mathematical Laboratory of the University of Edinburgh, graphical methods have been almost altogether abandoned. *Nature,* September 13, 1924, page 378.

§ 30. *Conclusion.*

Navigation is well nigh the oldest of all the arts, and, in modern times, it is certainly one of the most important. Its subject matter is interwoven with history and romance. From the Pinta, Nina, and Santa Maria to the Mauretania and Leviathan is a long, long interval; yet great as is the difference between the tiny caravels of Columbus and the modern giants of the ocean, there is an even greater difference between the art of navigation as known to Columbus and the perfected science of to-day. It is hard to realize that Columbus had no means of finding longitude. All that he could do, was to sail north or south until he reached a given latitude, and then sail east or west until land was reached somewhere. Long after Columbus, a writer of repute gives up the problem of longitude as hopeless, observing quaintly: ''Now there be some that are very inquisitive to have a way to get the longitude, but that is too tedious for seamen, since it requireth the deep knowledge of astronomy, wherefore I would not have any man think that the longitude is to be found at sea by any instrument; so let no seamen trouble themselves with any such rule, but (according to their accustomed manner) let them keep a perfect account and reckoning of the way of their ship.''*

In 1714 the English government offered a large reward for any method of determining longitude within 60 geographical miles; and if the new method fell short of this specification, one half the reward was to be paid in case accuracy within 80 geographical miles was reached. Even the great Sir Isaac Newton thought that a method of finding longitude within half a degree would be welcome. As late as 1774, among the things ''most worth finding'' in the world, Horace Walpole mentions the lost books of Livy, the philosopher's stone, etc., and makes double mention of ''the longitude.'' In these modern days of wireless, the longitude is no longer a hidden mystery.

Yet even in these days there is room for improvement, and it is not likely that the art of navigation will remain stationary. New methods will be discovered, and new facilities will be invented. Hence, navigators, with all their conservatism, may well give a hearing to any supposed improvement in their science.

In the light of these considerations, the present little book is offered to the public; and it is now brought to a close, in the hope that they that go down to the sea in ships and occupy their business in great waters, may find it a help towards bringing them unto the haven where they would be.

THE END

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* Quoted in Encyc. Brit. (11th ed.), Vol. 19, p. 284.

APPENDIX OF TABLES

Explanation of Tables

Table I, for the conversion of sidereal time into degrees, requires no comment. The last two columns can be used equally well for fractions of a second of time, by merely shifting the decimal point. For example, since $29^s = 7'.25$, $2^s.9 = 0'.725$, and $0^s.29 = 0'.0725$.

Table II gives the log sin of small angles up to 3°. This range covers all the cases that arise in determining a_1, ϑ_1, or A_z.

Table III gives the second latitude correction (a_2) for the arguments p and $(a + a_1)$. The table embraces all values of p from 0° to 360°. This correction (a_2) is always *subtractive.*

Table IV gives ϑ_2 with its proper sign for all values of p from 0° to 360°. The sign of ϑ_2 is always opposite to the sign of a_1.

Table V gives the trigonometrical functions of angles larger than 90° in terms of the functions of angles in the first quadrant. The whole table (except the signs) can be carried in memory by noting that the sin, cos, tan, etc., of $(180° \pm A)$ or of $(360° \pm A)$ are the same functions of A, while the sin, cos, tan, etc., of $(90° \pm A)$ or of $(270° \pm A)$ are the complementary functions of A. As to the signs, they are best remembered from the values of tan, cot, etc., in terms of the sine and cosine, the sine being positive in the first two quadrants and negative in the last two, and the cosine being positive in the first and fourth quadrants and negative in the other two.

Table VI gives for each day in the year 1925 the right ascension of the North Star (expressed in arc), log cos *d,* and the sid. time of the beginning of the Greenwich civil day. The right ascension of the North Star is given for the upper transit of Polaris at Greenwich. This conforms to the arrangement in the Nautical almanacs. No interpolation is necessary for any other hour of the day, for *RAN* is used only in the sum *RAN* + *n*, which is practically invariable for periods as short as a day.

Table VII gives *c*, log cosec *c*, and *RAN* + *n* for 27 selected stars at intervals of ten days throughout the year 1925. The stars are arranged in the order of their right ascensions. A list of them is given at the beginning of the table, and also in the Table of Contents, page 8. *RAN* + *n* is expressed in arc. This function varies very slowly, and the computer may take the value which is nearest to the date with which he is concerned.

TABLE I

To Convert Sidereal Time into Degrees

Time	Arc	Time	Arc		Time	Arc	Time	Arc
Hours	°	Min.	°	′	Sec.	′	Sec.	′
1	15	1	0	15	1	0.25	0.1	0.025
2	30	2	0	30	2	.50	.2	.05
3	45	3	0	45	3	.75	.3	.075
4	60	4	1	0	4	1.00	.4	.1
5	75	5	1	15	5	1.25	.5	.125
6	90	6	1	30	6	1.50	.6	.15
7	105	7	1	45	7	1.75	.7	.175
8	120	8	2	0	8	2.00	.8	.2
9	135	9	2	15	9	2.25	.9	.225
10	150	10	2	30	10	2.50		
11	165	11	2	45	11	2.75		
12	180	12	3	0	12	3.00		
13	195	13	3	15	13	3.25		
14	210	14	3	30	14	3.50		
15	225	15	3	45	15	3.75		
16	240	16	4	0	16	4.00		
17	255	17	4	15	17	4.25		
18	270	18	4	30	18	4.50		
19	285	19	4	45	19	4.75		
20	300	20	5	0	20	5.00		
21	315	21	5	15	21	5.25		
22	330	22	5	30	22	5.50		
23	345	23	5	45	23	5.75		
24	360	24	6	0	24	6.00		
		25	6	15	25	6.25		
		26	6	30	26	6.50		
		27	6	45	27	6.75		
		28	7	0	28	7.00		
		29	7	15	29	7.25		
		30	7	30	30	7.50		
		31	7	45	31	7.75		
		32	8	0	32	8.00		
		33	8	15	33	8.25		
		34	8	30	34	8.50		
		35	8	45	35	8.75		
		36	9	0	36	9.00		
		37	9	15	37	9.25		
		38	9	30	38	9.50		
		39	9	45	39	9.75		
		40	10	0	40	10.00		
		41	10	15	41	10.25		
		42	10	30	42	10.50		
		43	10	45	43	10.75		
		44	11	0	44	11.00		
		45	11	15	45	11.25		
		46	11	30	46	11.50		
		47	11	45	47	11.75		
		48	12	0	48	12.00		
		49	12	15	49	12.25		
		50	12	30	50	12.50		
		51	12	45	51	12.75		
		52	13	0	52	13.00		
		53	13	15	53	13.25		
		54	13	30	54	13.50		
		55	13	45	55	13.75		
		56	14	0	56	14.00		
		57	14	15	57	14.25		
		58	14	30	58	14.50		
		59	14	45	59	14.75		
		60	15	0	60	15.00		

TABLE II

Logarithmic Sines of Small Angles

0°

0°0′.0	0.0000	0°6′.0	7.2419	0°12′.0	7.5429	0°18′.0	7.7190	0°24′.0	7.8439
.1	5.4637	.1	.2491	.1	.5465	.1	.7214	.1	.8457
.2	.7648	.2	.2561	.2	.5501	.2	.7238	.2	.8475
.3	.9408	.3	.2631	.3	.5536	.3	.7262	.3	.8493
.4	6.0658	.4	.2699	.4	.5571	.4	.7285	.4	.8511
.5	.1627	.5	.2766	.5	.5606	.5	.7309	.5	.8529
.6	.2419	.6	.2833	.6	.5641	.6	.7332	.6	.8547
.7	.3088	.7	.2898	.7	.5675	.7	.7356	.7	.8564
.8	.3668	.8	.2962	.8	.5709	.8	.7379	.8	.8582
.9	.4180	.9	.3026	.9	.5743	.9	.7402	.9	.8599
0 1 .0	6.4637	0 7 .0	7.3088	0 13 .0	7.5777	0 19 .0	7.7425	0 25 .0	7.8617
.1	.5051	.1	.3150	.1	.5810	.1	.7448	.1	.8634
.2	.5429	.2	.3211	.2	.5843	.2	.7470	.2	.8651
.3	.5777	.3	.3270	.3	.5876	.3	.7493	.3	.8668
.4	.6099	.4	.3330	.4	.5908	.4	.7515	.4	.8686
.5	.6398	.5	.3388	.5	.5941	.5	.7538	.5	.8703
.6	.6678	.6	.3445	.6	.5973	.6	.7560	.6	.8720
.7	.6942	.7	.3502	.7	.6004	.7	.7582	.7	.8737
.8	.7190	.8	.3558	.8	.6036	.8	.7604	.8	.8753
.9	.7425	.9	.3614	.9	.6067	.9	.7626	.9	.8770
0 2 .0	6.7648	0 8 .0	7.3668	0 14 .0	7.6099	0 20 .0	7.7648	0 26 .0	7.8787
.1	.7859	.1	.3722	.1	.6129	.1	.7669	.1	.8804
.2	.8061	.2	.3775	.2	.6160	.2	.7691	.2	.8820
.3	.8255	.3	.3828	.3	.6191	.3	.7712	.3	.8837
.4	.8439	.4	.3880	.4	.6221	.4	.7734	.4	.8853
.5	.8617	.5	.3931	.5	.6251	.5	.7755	.5	.8870
.6	.8787	.6	.3982	.6	.6281	.6	.7776	.6	.8886
.7	.8951	.7	.4032	.7	.6310	.7	.7797	.7	.8902
.8	.9109	.8	.4082	.8	.6340	.8	.7818	.8	.8919
.9	.9261	.9	.4131	.9	.6369	.9	.7839	.9	.8935
0 3 .0	6.9408	0 9 .0	7.4180	0 15 .0	7.6398	0 21 .0	7.7859	0 27 .0	7.8951
.1	.9551	.1	.4228	.1	.6427	.1	.7880	.1	.8967
.2	.9689	.2	.4275	.2	.6456	.2	.7901	.2	.8983
.3	.9822	.3	.4322	.3	.6484	.3	.7921	.3	.8999
.4	.9952	.4	.4369	.4	.6512	.4	.7941	.4	.9015
.5	7.0078	.5	.4414	.5	.6541	.5	.7962	.5	.9031
.6	.0200	.6	.4460	.6	.6568	.6	.7982	.6	.9046
.7	.0319	.7	.4505	.7	.6596	.7	.8002	.7	.9062
.8	.0435	.8	.4550	.8	.6624	.8	.8022	.8	.9078
.9	.0548	.9	.4594	.9	.6651	.9	.8042	.9	.9093
0 4 .0	7.0658	0 10 .0	7.4637	0 16 .0	7.6678	0 22 .0	7.8061	0 28 .0	7.9109
.1	.0765	.1	.4680	.1	.6706	.1	.8081	.1	.9124
.2	.0870	.2	.4723	.2	.6732	.2	.8101	.2	.9140
.3	.0972	.3	.4766	.3	.6759	.3	.8120	.3	.9155
.4	.1072	.4	.4808	.4	.6786	.4	.8140	.4	.9170
.5	.1169	.5	.4849	.5	.6812	.5	.8159	.5	.9186
.6	.1265	.6	.4890	.6	.6838	.6	.8178	.6	.9201
.7	.1358	.7	.4931	.7	.6864	.7	.8197	.7	.9216
.8	.1450	.8	.4971	.8	.6890	.8	.8217	.8	.9231
.9	.1539	.9	.5012	.9	.6916	.9	.8236	.9	.9246
0 5 .0	7.1627	0 11 .0	7.5051	0 17 .0	7.6942	0 23 .0	7.8255	0 29 .0	7.9261
.1	.1713	.1	.5090	.1	.6967	.1	.8273	.1	.9276
.2	.1797	.2	.5129	.2	.6993	.2	.8292	.2	.9291
.3	.1880	.3	.5168	.3	.7018	.3	.8311	.3	.9306
.4	.1961	.4	.5206	.4	.7043	.4	.8329	.4	.9321
.5	.2041	.5	.5244	.5	.7068	.5	.8348	.5	.9335
.6	.2119	.6	.5282	.6	.7092	.6	.8366	.6	.9350
.7	.2196	.7	.5319	.7	.7117	.7	.8385	.7	.9365
.8	.2272	.8	.5356	.8	.7141	.8	.8403	.8	.9379
.9	.2346	.9	.5393	.9	.7166	.9	.8421	.9	.9394
0 6 .0	7.2419	0 12 .0	7.5429	0 18 .0	7.7190	0 24 .0	7.8439	0 30 .0	7.9408

TABLE II—(*Continued*)

Logarithmic Sines of Small Angles

0°

0°30′.0	7.9408	0°36′.0	8.0200	0°42′.0	8.0870	0°48′.0	8.1450	0°54′.0	8.1961
.1	.9423	.1	.0212	.1	.0880	.1	.1459	.1	.1969
.2	.9437	.2	.0224	.2	.0890	.2	.1468	.2	.1977
.3	.9452	.3	.0236	.3	.0901	.3	.1477	.3	.1985
.4	.9466	.4	.0248	.4	.0911	.4	.1486	.4	.1993
.5	.9480	.5	.0260	.5	.0921	.5	.1495	.5	.2001
.6	.9494	.6	.0272	.6	.0931	.6	.1503	.6	.2009
.7	.9509	.7	.0284	.7	.0941	.7	.1512	.7	.2017
.8	.9523	.8	.0296	.8	.0952	.8	.1521	.8	.2025
.9	.9537	.9	.0307	.9	.0962	.9	.1530	.9	.2033
0 31 .0	7.9551	0 37 .0	8.0319	0 43 .0	8.0972	0 49 .0	8.1539	0 55 .0	8.2041
.1	.9565	.1	.0331	.1	.0982	.1	.1548	.1	.2049
.2	.9579	.2	.0343	.2	.0992	.2	.1557	.2	.2056
.3	.9593	.3	.0354	.3	.1002	.3	.1566	.3	.2064
.4	.9606	.4	.0366	.4	.1012	.4	.1574	.4	.2072
.5	.9620	.5	.0377	.5	.1022	.5	.1583	.5	.2080
.6	.9634	.6	.0389	.6	.1032	.6	.1592	.6	.2088
.7	.9648	.7	.0401	.7	.1042	.7	.1601	.7	.2096
.8	.9661	.8	.0412	.8	.1052	.8	.1609	.8	.2103
.9	.9675	.9	.0424	.9	.1062	.9	.1618	.9	.2111
0 32 .0	7.9689	0 38 .0	8.0435	0 44 .0	8.1072	0 50 .0	8.1627	0 56 .0	8.2119
.1	.9702	.1	.0446	.1	.1082	.1	.1635	.1	.2127
.2	.9716	.2	.0458	.2	.1091	.2	.1644	.2	.2134
.3	.9729	.3	.0469	.3	.1101	.3	.1653	.3	.2142
.4	.9743	.4	0480	.4	.1111	.4	.1661	.4	.2150
.5	.9756	.5	.0492	.5	.1121	.5	.1670	.5	.2158
.6	.9769	.6	.0503	.6	.1130	.6	.1679	.6	.2165
.7	.9783	.7	.0514	.7	.1140	.7	.1687	.7	.2173
.8	.9796	.8	.0525	.8	.1150	.8	.1696	.8	.2181
.9	.9809	.9	.0537	.9	.1160	.9	.1704	.9	.2188
0 33 .0	7.9822	0 39 .0	8.0548	0 45 .0	8.1169	0 51 .0	8.1713	0 57 .0	8.2196
.1	.9835	.1	.0559	.1	.1179	.1	.1721	.1	.2203
.2	.9849	.2	.0570	.2	.1189	.2	.1730	.2	.2211
.3	.9862	.3	.0581	.3	.1198	.3	.1738	.3	.2219
.4	.9875	.4	.0592	.4	.1208	.4	.1747	.4	.2226
.5	.9888	.5	.0603	.5	.1217	.5	.1755	.5	.2234
.6	.9901	.6	.0614	.6	.1227	.6	.1764	.6	.2241
.7	.9913	.7	.0625	.7	.1236	.7	.1772	.7	.2249
.8	.9926	.8	.0636	.8	.1246	.8	.1780	.8	.2256
.9	.9939	.9	.0647	.9	.1255	.9	.1789	.9	.2264
0 34 .0	7.9952	0 40 .0	8:0658	0 46 .0	8.1265	0 52 .0	8.1797	0 58 .0	8.2271
.1	.9965	.1	.0669	.1	.1274	.1	.1805	.1	.2279
.2	.9977	.2	.0679	.2	.1284	.2	.1814	.2	.2286
.3	.9990	.3	.0690	.3	.1293	.3	.1822	.3	.2294
.4	8.0003	.4	.0701	.4	.1302	.4	.1830	.4	.2301
.5	.0015	.5	.0712	.5	.1312	.5	.1839	.5	.2309
.6	.0028	.6	.0722	.6	.1321	.6	.1847	.6	.2316
.7	.0040	.7	.0733	.7	.1330	.7	.1855	.7	.2323
.8	.0053	.8	.0744	.8	.1340	.8	.1863	.8	.2331
.9	.0065	.9	.0754	.9	.1349	.9	.1872	.9	.2338
0 35 .0	8.0078	0 41 .0	8.0765	0 47 .0	8.1358	0 53 .0	8.1880	0 59 .0	8.2346
.1	.0090	.1	.0776	.1	.1367	.1	.1888	.1	.2353
.2	.0103	.2	.0786	.2	.1377	.2	.1896	.2	.2360
.3	.0115	.3	.0797	.3	.1386	.3	.1904	.3	.2368
.4	.0127	.4	.0807	.4	.1395	.4	.1912	.4	.2375
.5	.0139	.5	.0818	.5	.1404	.5	.1921	.5	.2382
.6	.0152	.6	.0828	.6	.1413	.6	.1929	.6	.2390
.7	.0164	.7	.0839	.7	.1422	.7	.1937	.7	.2397
.8	.0176	.8	.0849	.8	.1431	.8	.1945	.8	.2404
.9	.0188	.9	.0859	.9	.1440	.9	.1953	.9	.2411
0 36 .0	8.0200	0 42 .0	8.0870	0 48 .0	8.1450	0 54 .0	8.1961	0 60 .0	8.2419

TABLE II—(*Continued*)

Logarithmic Sines of Small Angles

1°

1°0′.0	8.2419	1°6′.0	8.2832	1°12′.0	8.3210	1°18′.0	8.3558	1°24′.0	8.3880
.1	.2426	.1	.2839	.1	.3216	.1	.3563	.1	.3885
.2	.2433	.2	.2846	.2	.3222	.2	.3569	.2	.3890
.3	.2440	.3	.2852	.3	.3228	.3	.3575	.3	.3895
.4	.2447	.4	.2859	.4	.3234	.4	.3580	.4	.3900
.5	.2455	.5	.2865	.5	.3240	.5	.3586	.5	.3905
.6	.2462	.6	.2872	.6	.3246	.6	.3591	.6	.3911
.7	.2469	.7	.2878	.7	.3252	.7	.3597	.7	.3916
.8	.2476	.8	.2885	.8	.3258	.8	.3602	.8	.3921
.9	.2483	.9	.2891	.9	.3264	.9	.3608	.9	.3926
1 1 .0	8.2490	1 7 .0	8.2898	1 13 .0	8.3270	1 19 .0	8.3613	1 25 .0	8.3931
.1	.2497	.1	.2904	.1	.3276	.1	.3619	.1	.3936
.2	.2505	.2	.2911	.2	.3282	.2	.3624	.2	.3941
.3	.2512	.3	.2917	.3	.3288	.3	.3630	.3	.3946
.4	.2519	.4	.2924	.4	.3294	.4	.3635	.4	.3951
.5	.2526	.5	.2930	.5	.3300	.5	.3641	.5	.3956
.6	.2533	.6	.2936	.6	.3306	.6	.3646	.6	.3962
.7	.2540	.7	.2943	.7	.3312	.7	.3651	.7	.3967
.8	.2547	.8	.2949	.8	.3317	.8	.3657	.8	.3972
.9	.2554	.9	.2956	.9	.3323	.9	.3662	.9	.3977
1 2 .0	8.2561	1 8 .0	8.2962	1 14 .0	8.3329	1 20 .0	8.3668	1 26 .0	8.3982
.1	.2568	.1	.2968	.1	.3335	.1	.3673	.1	.3987
.2	.2575	.2	.2975	.2	.3341	.2	.3679	.2	.3992
.3	.2582	.3	.2981	.3	.3347	.3	.3684	.3	.3997
.4	.2589	.4	.2988	.4	.3353	.4	.3689	.4	.4002
.5	.2596	.5	.2994	.5	.3358	.5	.3695	.5	.4007
.6	.2603	.6	.3000	.6	.3364	.6	.3700	.6	.4012
.7	.2610	.7	.3007	.7	.3370	.7	.3706	.7	.4017
.8	.2617	.8	.3013	.8	.3376	.8	.3711	.8	.4022
.9	.2624	.9	.3019	.9	.3382	.9	.3716	.9	.4027
1 3 .0	8.2630	1 9 .0	8.3025	1 15 .0	8.3388	1 21 .0	8.3722	1 27 .0	8.4032
.1	.2637	.1	.3032	.1	.3393	.1	.3727	.1	.4037
.2	.2644	.2	.3038	.2	.3399	.2	.3732	.2	.4042
.3	.2651	.3	.3044	.3	.3405	.3	.3738	.3	.4047
.4	.2658	.4	.3051	.4	.3411	.4	.3743	.4	.4052
.5	.2665	.5	.3057	.5	.3416	.5	.3748	.5	.4057
.6	.2672	.6	.3063	.6	.3422	.6	.3754	.6	.4062
.7	.2678	.7	.3069	.7	.3428	.7	.3759	.7	.4067
.8	.2685	.8	.3076	.8	.3434	.8	.3764	.8	.4072
.9	.2692	.9	.3082	.9	.3439	.9	.3770	.9	.4077
1 4 .0	8.2699	1 10 .0	8.3088	1 16 .0	8.3445	1 22 .0	8.3775	1 28 .0	8.4082
.1	.2706	.1	.3094	.1	.3451	.1	.3780	.1	.4087
.2	.2712	.2	.3100	.2	.3456	.2	.3786	.2	.4091
.3	.2719	.3	.3107	.3	.3462	.3	.3791	.3	.4096
.4	.2726	.4	.3113	.4	.3468	.4	.3796	.4	.4101
.5	.2733	.5	.3119	.5	.3474	.5	.3801	.5	.4106
.6	.2739	.6	.3125	.6	.3479	.6	.3807	.6	.4111
.7	.2746	.7	.3131	.7	.3485	.7	.3812	.7	.4116
.8	.2753	.8	.3137	.8	.3491	.8	.3817	.8	.4121
.9	.2759	.9	.3143	.9	.3496	.9	.3822	.9	.4126
1 5 .0	8.2766	1 11 .0	8.3150	1 17 .0	8.3502	1 23 .0	8.3828	1 29 .0	8.4131
.1	.2773	.1	.3156	.1	.3507	.1	.3833	.1	.4136
.2	.2779	.2	.3162	.2	.3513	.2	.3838	.2	.4140
.3	.2786	.3	.3168	.3	.3519	.3	.3843	.3	.4145
.4	.2793	.4	.3174	.4	.3524	.4	.3848	.4	.4150
.5	.2799	.5	.3180	.5	.3530	.5	.3854	.5	.4155
.6	.2806	.6	.3186	.6	.3536	.6	.3859	.6	.4160
.7	.2813	.7	.3192	.7	.3541	.7	.3864	.7	.4165
.8	.2819	.8	.3198	.8	.3547	.8	.3869	.8	.4170
.9	.2826	.9	.3204	.9	.3552	.9	.3874	.9	.4174
1 6 .0	8.2832	1 12 .0	8.3210	1 18 .0	8.3558	1 24 .0	8.3880	1 30 .0	8.4179

TABLE II—(*Continued*)

Logarithmic Sines of Small Angles

1°

1°30′.0	8.4179	1°36′.0	8.4459	1°42′.0	8.4723	1°48′.0	8.4971	1°54′.0	8.5206
.1	.4184	.1	.4464	.1	.4727	.1	.4975	.1	.5209
.2	.4189	.2	.4468	.2	.4731	.2	.4979	.2	.5213
.3	.4194	.3	.4473	.3	.4735	.3	.4983	.3	.5217
.4	.4198	.4	.4477	.4	.4740	.4	.4987	.4	.5221
.5	.4203	.5	.4482	.5	.4744	.5	.4991	.5	.5225
.6	.4208	.6	.4486	.6	.4748	.6	.4995	.6	.5228
.7	.4213	.7	.4491	.7	.4752	.7	.4999	.7	.5232
.8	.4218	.8	.4495	.8	.4757	.8	.5003	.8	.5236
.9	.4222	.9	.4500	.9	.4761	.9	.5007	.9	.5240
1 31 .0	8.4227	1 37 .0	8.4504	1 43 .0	8.4765	1 49 .0	8.5011	1 55 .0	8.5243
.1	.4232	.1	.4509	.1	.4769	.1	.5015	.1	.5247
.2	.4237	.2	.4513	.2	.4773	.2	.5019	.2	.5251
.3	.4241	.3	.4518	.3	.4778	.3	.5023	.3	.5255
.4	.4246	.4	.4522	.4	.4782	.4	.5027	.4	.5259
.5	.4251	.5	.4527	.5	.4786	.5	.5031	.5	.5262
.6	.4256	.6	.4531	.6	.4790	.6	.5035	.6	.5266
.7	.4260	.7	.4536	.7	.4794	.7	.5039	.7	.5270
.8	.4265	.8	.4540	.8	.4799	.8	.5043	.8	.5274
.9	.4270	.9	.4545	.9	.4803	.9	.5046	.9	.5277
1 32 .0	8.4275	1 38 .0	8.4549	1 44 .0	8.4807	1 50 .0	8.5050	1 56 .0	8.5281
.1	.4279	.1	.4553	.1	.4811	.1	.5054	.1	.5285
.2	.4284	.2	.4558	.2	.4815	.2	.5058	.2	.5288
.3	.4289	.3	.4562	.3	.4819	.3	.5062	.3	.5292
.4	.4293	.4	.4567	.4	.4824	.4	.5066	.4	.5296
.5	.4298	.5	.4571	.5	.4828	.5	.5070	.5	.5300
.6	.4303	.6	.4575	.6	.4832	.6	.5074	.6	.5303
.7	.4308	.7	.4580	.7	.4836	.7	.5078	.7	.5307
.8	.4312	.8	.4584	.8	.4840	.8	.5082	.8	.5311
.9	.4317	.9	.4589	.9	.4844	.9	.5086	.9	.5315
1 33 .0	8.4322	1 39 .0	8.4593	1 45 .0	8.4848	1 51 .0	8.5090	1.57 .0	8.5318
.1	.4326	.1	.4597	.1	.4853	.1	.5094	.1	.5322
.2	.4331	.2	.4602	.2	.4857	.2	.5098	.2	.5326
.3	.4336	.3	.4606	.3	.4861	.3	.5101	.3	.5329
.4	.4340	.4	.4611	.4	.4865	.4	.5105	.4	.5333
.5	.4345	.5	.4615	.5	.4869	.5	.5109	.5	.5337
.6	.4349	.6	.4619	.6	.4873	.6	.5113	.6	.5340
.7	.4354	.7	.4624	.7	.4877	.7	.5117	.7	.5344
.8	.4359	.8	.4628	.8	.4881	.8	.5121	.8	.5348
.9	.4363	.9	.4632	.9	.4886	.9	.5125	.9	.5352
1 34 .0	8.4368	1 40 .0	8.4637	1 46 .0	8.4890	1 52 .0	8.5129	1 58 .0	8.5355
.1	.4373	.1	.4641	.1	.4894	.1	.5133	.1	.5359
.2	.4377	.2	.4645	.2	.4898	.2	.5136	.2	.5363
.3	.4382	.3	.4650	.3	.4902	.3	.5140	.3	.5366
.4	.4386	.4	.4654	.4	.4906	.4	.5144	.4	.5370
.5	.4391	.5	.4658	.5	.4910	.5	.5148	.5	.5374
.6	.4396	.6	.4663	.6	.4914	.6	.5152	.6	.5377
.7	.4400	.7	.4667	.7	.4918	.7	.5156	.7	.5381
.8	.4405	.8	.4671	.8	.4922	.8	.5160	.8	.5385
.9	.4409	.9	.4676	.9	.4926	.9	.5163	.9	.5388
1 35 .0	8.4414	1 41 .0	8.4680	1 47 .0	8.4930	1 53 .0	8.5167	1 59 .0	8.5392
.1	.4419	.1	.4684	.1	.4934	.1	.5171	.1	.5396
.2	.4423	.2	.4688	.2	.4939	.2	.5175	.2	.5399
.3	.4428	.3	.4693	.3	.4943	.3	.5179	.3	.5403
.4	.4432	.4	.4697	.4	.4947	.4	.5183	.4	.5406
.5	.4437	.5	.4701	.5	.4951	.5	.5186	.5	.5410
.6	.4441	.6	.4706	.6	.4955	.6	.5190	.6	.5414
.7	.4446	.7	.4710	.7	.4959	.7	.5194	.7	.5417
.8	.4450	.8	.4714	.8	.4963	.8	.5198	.8	.5421
.9	.4455	.9	.4718	.9	.4967	.9	.5202	.9	.5425
1 36 .0	8.4459	1 42 .0	8.4723	1 48 .0	8.4971	1 54 .0	8.5206	1 60 .0	8.5428

TABLE II—(*Continued*)

Logarithmic Sines of Small Angles

2°

2°0′.0	8.5428	2°6′.0	8.5640	2°12′.0	8.5842	2°18′.0	8.6035	2°24′.0	8.6220
.1	.5432	.1	.5643	.1	.5845	.1	.6038	.1	.6223
.2	.5435	.2	.5647	.2	.5849	.2	.6041	.2	.6226
.3	.5439	.3	.5650	.3	.5852	.3	.6044	.3	.6229
.4	.5443	.4	.5654	.4	.5855	.4	.6047	.4	.6232
.5	.5446	.5	.5657	.5	.5858	.5	.6051	.5	.6235
.6	.5450	.6	.5661	.6	.5862	.6	.6054	.6	.6238
.7	.5453	.7	.5664	.7	.5865	.7	.6057	.7	.6241
.8	.5457	.8	.5667	.8	.5868	.8	.6060	.8	.6244
.9	.5461	.9	.5671	.9	.5871	.9	.6063	.9	.6247
2 1 .0	8.5464	2 7 .0	8.5674	2 13 .0	8.5875	2 19 .0	8.6066	2 25 .0	8.6250
.1	.5468	.1	.5678	.1	.5878	.1	.6069	.1	.6253
.2	.5471	.2	.5681	.2	.5881	.2	.6072	.2	.6256
.3	.5475	.3	.5685	.3	.5884	.3	.6076	.3	.6259
.4	.5479	.4	.5688	.4	.5888	.4	.6079	.4	.6262
.5	.5482	.5	.5691	.5	.5891	.5	.6082	.5	.6265
.6	.5486	.6	.5695	.6	.5894	.6	.6085	.6	.6268
.7	.5489	.7	.5698	.7	.5897	.7	.6088	.7	.6271
.8	.5493	.8	.5702	.8	.5901	.8	.6091	.8	.6274
.9	.5496	.9	.5705	.9	.5904	.9	.6094	.9	.6277
2 2 .0	8.5500	2 8 .0	8.5708	2 14 .0	8.5907	2 20 .0	8.6097	2 26 .0	8.6279
.1	.5504	.1	.5712	.1	.5910	.1	.6100	.1	.6282
.2	.5507	.2	.5715	.2	.5914	.2	.6104	.2	.6285
.3	.5511	.3	.5719	.3	.5917	.3	.6107	.3	.6288
.4	.5514	.4	.5722	.4	.5920	.4	.6110	.4	.6291
.5	.5518	.5	.5725	.5	.5923	.5	.6113	.5	.6294
.6	.5521	.6	.5729	.6	.5927	.6	.6116	.6	.6297
.7	.5525	.7	.5732	.7	.5930	.7	.6119	.7	.6300
.8	.5528	.8	.5735	.8	.5933	.8	.6122	.8	.6303
.9	.5532	.9	.5739	.9	.5936	.9	.6125	.9	.6306
2 3 .0	8.5535	2 9 .0	8.5742	2 15 .0	8.5939	2 21 .0	8.6128	2 27 .0	8.6309
.1	.5539	.1	.5746	.1	.5943	.1	.6131	.1	.6312
.2	.5542	.2	.5749	.2	.5946	.2	.6134	.2	.6315
.3	.5546	.3	.5752	.3	.5949	.3	.6137	.3	.6318
.4	.5549	.4	.5756	.4	.5952	.4	.6141	.4	.6321
.5	.5553	.5	.5759	.5	.5956	.5	.6144	.5	.6324
.6	.5557	.6	.5762	.6	.5959	.6	.6147	.6	.6327
.7	.5560	.7	.5766	.7	.5962	.7	.6150	.7	.6330
.8	.5564	.8	.5769	.8	.5965	.8	.6153	.8	.6333
.9	.5567	.9	.5772	.9	.5968	.9	.6156	.9	.6336
2 4 .0	8.5571	2 10 .0	8.5776	2 16 .0	8.5972	2 22 .0	8.6159	2 28 .0	8.6339
.1	.5574	.1	.5779	.1	.5975	.1	.6162	.1	.6341
.2	.5578	.2	.5782	.2	.5978	.2	.6165	.2	.6344
.3	.5581	.3	.5786	.3	.5981	.3	.6168	.3	.6347
.4	.5585	.4	.5789	.4	.5984	.4	.6171	.4	.6350
.5	.5588	.5	.5792	.5	.5987	.5	.6174	.5	.6353
.6	.5591	.6	.5796	.6	.5991	.6	.6177	.6	.6356
.7	.5595	.7	.5799	.7	.5994	.7	.6180	.7	.6359
.8	.5598	.8	.5802	.8	.5997	.8	.6183	.8	.6362
.9	.5602	.9	.5806	.9	.6000	.9	.6186	.9	.6365
2 5 .0	8.5605	2 11 .0	8.5809	2 17 .0	8.6003	2 23 .0	8.6189	2 29 .0	8.6368
.1	.5609	.1	.5812	.1	.6006	.1	.6192	.1	.6371
.2	.5612	.2	.5816	.2	.6010	.2	.6195	.2	.6374
.3	.5616	.3	.5819	.3	.6013	.3	.6198	.3	.6376
.4	.5619	.4	.5822	.4	.6016	.4	.6201	.4	.6379
.5	.5623	.5	.5825	.5	.6019	.5	.6205	.5	.6382
.6	.5626	.6	.5829	.6	.6022	.6	.6208	.6	.6385
.7	.5630	.7	.5832	.7	.6025	.7	.6211	.7	.6388
.8	.5633	.8	.5835	.8	.6029	.8	.6214	.8	.6391
.9	.5637	.9	.5839	.9	.6032	.9	.6217	.9	.6394
2 6 .0	8.5640	2 12 .0	8.5842	2 18 .0	8.6035	2 24 .0	8.6220	2 30 .0	8.6397

TABLE II—(*Continued*)

Logarithmic Sines of Small Angles

2°

2°30′.0	8.6397	2°36′.0	8.6567	2°42′.0	8.6731	2°48′.0	8.6889	2°54′.0	8.7041
.1	.6400	.1	.6570	.1	.6733	.1	.6891	.1	.7043
.2	.6403	.2	.6573	.2	.6736	.2	.6894	.2	.7046
.3	.6405	.3	.6575	.3	.6739	.3	.6896	.3	.7048
.4	.6408	.4	.6578	.4	.6742	.4	.6899	.4	.7051
.5	.6411	.5	.6581	.5	.6744	.5	.6902	.5	.7053
.6	.6414	.6	.6583	.6	.6747	.6	.6904	.6	.7056
.7	6417	.7	.6586	.7	.6750	.7	.6907	.7	.7058
.8	.6420	.8	.6589	.8	.6752	.8	.6909	.8	.7061
.9	.6423	.9	.6592	.9	.6755	.9	.6912	.9	.7063
2 31 .0	8.6426	2 37 .0	8.6595	2 43 .0	8.6758	2 49 .0	8.6914	2 55 .0	8.7066
.1	.6429	.1	.6598	.1	.6760	.1	.6917	.1	.7068
.2	.6431	.2	.6600	.2	.6763	.2	.6920	.2	.7071
.3	.6434	.3	.6603	.3	.6765	.3	.6922	.3	.7073
.4	.6437	.4	.6606	.4	.6768	.4	.6925	.4	.7076
.5	.6440	.5	.6609	.5	.6771	.5	.6927	.5	.7078
.6	.6443	.6	.6611	.6	.6773	.6	.6930	.6	.7081
.7	.6446	.7	.6614	.7	.6776	.7	.6932	.7	.7083
.8	.6449	.8	.6617	.8	.6779	.8	.6935	.8	.7086
.9	.6451	.9	.6620	.9	.6781	.9	.6937	.9	.7088
2 32 .0	8.6454	2 38 .0	8.6622	2 44 .0	8.6784	2 50 .0	8.6940	2 56 .0	8.7090
.1	.6457	.1	.6625	.1	.6787	.1	.6943	.1	.7093
.2	.6460	.2	.6628	.2	.6789	.2	.6945	.2	.7095
.3	.6463	.3	.6631	.3	.6792	.3	.6948	.3	.7098
.4	.6466	.4	.6633	.4	.6795	.4	.6950	.4	.7100
.5	.6469	.5	.6636	.5	.6797	.5	.6953	.5	.7103
.6	.6471	.6	.6639	.6	.6800	.6	.6955	.6	.7105
.7	.6474	.7	.6641	.7	.6803	.7	.6958	.7	.7108
.8	.6477	.8	.6644	.8	.6805	.8	.6960	.8	.7110
.9	.6480	.9	.6647	.9	.6808	.9	.6963	.9	.7113
2 33 .0	8.6483	2 39 .0	8.6650	2 45 .0	8.6810	2 51 .0	8.6965	2 57 .0	8.7115
.1	.6486	.1	.6652	.1	.6813	.1	.6968	.1	.7118
.2	.6488	.2	.6655	.2	.6816	.2	.6971	.2	.7120
.3	.6491	.3	.6658	.3	.6818	.3	.6973	.3	.7122
.4	.6494	.4	.6661	.4	.6821	.4	.6976	.4	.7125
.5	.6497	.5	.6663	.5	.6824	.5	.6978	.5	.7127
.6	.6500	.6	.6666	.6	.6826	.6	.6981	.6	.7130
.7	.6503	.7	.6669	.7	.6829	.7	.6983	.7	.7132
.8	.6505	.8	.6671	.8	.6831	.8	.6986	.8	.7135
.9	.6508	.9	.6674	.9	.6834	.9	.6988	.9	.7137
2 34 .0	8.6511	2 40 .0	8.6677	2 46 .0	8.6837	2 52 .0	8.6991	2 58 .0	8.7140
.1	.6514	.1	.6680	.1	.6839	.1	.6993	.1	.7142
.2	.6517	.2	.6682	.2	.6842	.2	.6996	.2	.7144
.3	.6519	.3	.6685	.3	.6844	.3	.6998	.3	.7147
.4	.6522	.4	.6688	.4	.6847	.4	.7001	.4	.7149
.5	.6525	.5	.6690	.5	.6850	.5	.7003	.5	.7152
.6	.6528	.6	.6693	.6	.6852	.6	.7006	.6	.7154
.7	.6531	.7	.6696	.7	.6855	.7	.7008	.7	.7157
.8	.6534	.8	.6699	.8	.6858	.8	.7011	.8	.7159
.9	.6536	.9	.6701	.9	.6860	.9	.7013	.9	.7161
2 35 .0	8.6539	2 41 .0	8.6704	2 47 .0	8.6863	2 53 .0	8.7016	2 59 .0	8.7164
.1	.6542	.1	.6707	.1	.6865	.1	.7018	.1	.7166
.2	.6545	.2	.6709	.2	.6868	.2	.7021	.2	.7169
.3	.6547	.3	.6712	.3	.6871	.3	.7023	.3	.7171
.4	.6550	.4	.6715	.4	.6873	.4	.7026	.4	.7174
.5	.6553	.5	.6717	.5	.6876	.5	.7028	.5	.7176
.6	.6556	.6	.6720	.6	.6878	.6	.7031	.6	.7178
.7	.6559	.7	.6723	.7	.6881	.7	.7033	.7	.7181
.8	.6561	.8	.6725	.8	.6883	.8	.7036	.8	.7183
.9	.6564	.9	.6728	.9	.6886	.9	.7038	.9	.7186
2 36 .0	8.6567	2 42 .0	8.6731	2 48 .0	8.6889	2 54 .0	8.7041	2 60 .0	8.7188

TABLE III

Latitude Correction (a_2)

	p ° 0	p ° 1	p ° 2	p ° 3	p ° 4	p ° 5	p ° 6	p ° 7	p ° 8	p ° 9	p ° 10	p ° 11	p ° 12	p ° 13	p ° 14
	180	179	178	177	176	175	174	173	172	171	170	169	168	167	166
	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194
	360	359	358	357	356	355	354	353	352	351	350	349	348	347	346
$a + a_1$	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
13	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
14	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
15	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
16	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
17	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
18	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
19	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
22	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
23	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
24	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
25	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
26	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
27	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
28	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
29	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
33	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
34	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
35	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
36	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
37	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
38	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
39	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
42	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
43	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
44	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
45	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
46	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
47	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
48	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
49	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
51	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
52	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
53	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
54	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1
55	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1
56	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1
57	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1
58	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1
59	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1
60	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
61	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1
62	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1
63	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1
64	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1
65	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1
66	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1
67	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1
68	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1
69	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1
70	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1

TABLE III — (*Continued*)

LATITUDE CORRECTION (a_2)

	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
	165	164	163	162	161	160	159	158	157	156	155	154	153	152	151
	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209
	345	344	343	342	341	340	339	338	337	336	335	334	333	332	331
$a + a_1$	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
13	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
14	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
15	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
16	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
17	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
18	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
19	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
21	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1
22	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1
23	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1
24	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1
25	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1
26	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1
27	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1
28	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1
29	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1
30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
31	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1
32	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1
33	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1
34	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1
35	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
36	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
37	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
38	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
39	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
40	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
41	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
42	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
43	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
44	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
45	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
46	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2
47	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2
48	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2
49	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2
50	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2
51	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2
52	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2
53	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2
54	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2
55	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2
56	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2
57	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2
58	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2
59	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2
60	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3
61	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2	.3
62	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2	.3	.3
63	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.3	.3	.3
64	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2	.3	.3	.3
65	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.3	.3	.3	.3
66	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3
67	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3
68	.1	.1	.1	.1	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3	.4
69	.1	.1	.1	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3	.4	.4
70	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.4	0.4	0.4

TABLE III — (*Continued*)

LATITUDE CORRECTION (a_2)

	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
	150	149	148	147	146	145	144	143	142	141	140	139	138	137	136
	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224
	330	329	328	327	326	325	324	323	322	321	320	319	318	317	316
$a+a_1$	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
11	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1
12	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1
13	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1
14	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
15	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
16	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
17	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
18	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
19	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
20	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
21	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
22	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
23	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
24	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
25	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
26	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
27	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2
28	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2
29	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2
30	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2
31	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2
32	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2
33	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2
34	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2	.2
35	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2
36	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
37	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
38	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
39	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
40	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3
41	.1	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.3	.3
42	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.3	.3	.3
43	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.3	.3	.3	.3
44	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3
45	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3
46	.2	.2	.2	.2	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3
47	.2	.2	.2	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3	.3
48	.2	.2	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3	.3	.3
49	.2	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3	.3	.3	.4
50	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4
51	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3	.3	.3	.4	.4
52	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3	.3	.3	.4	.4	.4
53	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3	.3	.4	.4	.4	.4
54	.2	.2	.2	.3	.3	.3	.3	.3	.3	.3	.4	.4	.4	.4	.4
55	.2	.2	.3	.3	.3	.3	.3	.3	.3	.4	.4	.4	.4	.4	.4
56	.2	.2	.3	.3	.3	.3	.3	.3	.4	.4	.4	.4	.4	.4	.5
57	.2	.3	.3	.3	.3	.3	.3	.4	.4	.4	.4	.4	.4	.5	.5
58	.3	.3	.3	.3	.3	.3	.3	.4	.4	.4	.4	.4	.5	.5	.5
59	.3	.3	.3	.3	.3	.3	.4	.4	.4	.4	.4	.5	.5	.5	.5
60	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5
61	.3	.3	.3	.3	.4	.4	.4	.4	.4	.4	.5	.5	.5	.5	.5
62	.3	.3	.3	.4	.4	.4	.4	.4	.4	.5	.5	.5	.5	.6	.6
63	.3	.3	.3	.4	.4	.4	.4	.4	.5	.5	.5	.5	.6	.6	.6
64	.3	.3	.4	.4	.4	.4	.4	.5	.5	.5	.5	.6	.6	.6	.6
65	.3	.4	.4	.4	.4	.4	.5	.5	.5	.5	.6	.6	.6	.6	.7
66	.4	.4	.4	.4	.4	.5	.5	.5	.5	.6	.6	.6	.6	.7	.7
67	.4	.4	.4	.4	.5	.5	.5	.5	.6	.6	.6	.6	.7	.7	.7
68	.4	.4	.4	.5	.5	.5	.5	.6	.6	.6	.6	.7	.7	.7	.8
69	.4	.4	.5	.5	.5	.5	.6	.6	.6	.6	.7	.7	.7	.8	.8
70	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.8	0.8	0.8

TABLE III — (*Continued*)

LATITUDE CORRECTION (a_2)

	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59
	135	134	133	132	131	130	129	128	127	126	125	124	123	122	121
	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239
	315	314	313	312	311	310	309	308	307	306	305	304	303	302	301
$a + a_1$	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1
8	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
9	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
10	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
11	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
12	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
13	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
14	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
15	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
16	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
17	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
18	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2
19	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2
20	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2
21	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2	.2
22	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2
23	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
24	.1	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
25	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
26	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
27	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
28	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
29	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.3	.3
30	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3
31	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3
32	.2	.2	.2	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3	.3
33	.2	.2	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3	.3	.3
34	.2	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3	.3	.3	.3
35	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
36	.2	.2	.2	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
37	.2	.2	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
38	.2	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.4	.4
39	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.4	.4	.4	.4
40	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4
41	.3	.3	.3	.3	.3	.3	.3	.3	.3	.4	.4	.4	.4	.4	.4
42	.3	.3	.3	.3	.3	.3	.3	.4	.4	.4	.4	.4	.4	.4	.4
43	.3	.3	.3	.3	.3	.3	.4	.4	.4	.4	.4	.4	.4	.4	.4
44	.3	.3	.3	.3	.3	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4
45	.3	.3	.3	.3	.4	.4	.4	.4	.4	.4	.4	.4	.4	.5	.5
46	.3	.3	.3	.4	.4	.4	.4	.4	.4	.4	.4	.4	.5	.5	.5
47	.3	.4	.4	.4	.4	.4	.4	.4	.4	.4	.5	.5	.5	.5	.5
48	.4	.4	.4	.4	.4	.4	.4	.4	.4	.5	.5	.5	.5	.5	.5
49	.4	.4	.4	.4	.4	.4	.4	.5	.5	.5	.5	.5	.5	.5	.5
50	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6
51	.4	.4	.4	.4	.4	.5	.5	.5	.5	.5	.5	.5	.5	.6	.6
52	.4	.4	.4	.4	.5	.5	.5	.5	.5	.5	.5	.6	.6	.6	.6
53	.4	.4	.4	.5	.5	.5	.5	.5	.5	.5	.6	.6	.6	.6	.6
54	.4	.4	.5	.5	.5	.5	.5	.5	.6	.6	.6	.6	.6	.6	.6
55	.4	.5	.5	.5	.5	.5	.5	.6	.6	.6	.6	.6	.6	.6	.7
56	.5	.5	.5	.5	.5	.5	.6	.6	.6	.6	.6	.6	.7	.7	.7
57	.5	.5	.5	.5	.6	.6	.6	.6	.6	.6	.7	.7	.7	.7	.7
58	.5	.5	.5	.6	.6	.6	.6	.6	.6	.7	.7	.7	.7	.7	.7
59	.5	.5	.6	.6	.6	.6	.6	.7	.7	.7	.7	.7	.7	.8	.8
60	0.5	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8
61	.6	.6	.6	.6	.6	.7	.7	.7	.7	.7	.8	.8	.8	.8	.8
62	.6	.6	.6	.7	.7	.7	.7	.7	.8	.8	.8	.8	.8	.9	.9
63	.6	.6	.7	.7	.7	.7	.7	.8	.8	.8	.8	.9	.9	.9	.9
64	.6	.7	.7	.7	.7	.8	.8	.8	.8	.8	.9	.9	.9	.9	.9
65	.7	.7	.7	.7	.8	.8	.8	.8	.9	.9	.9	.9	1.0	1.0	1.0
66	.7	.7	.8	.8	.8	.8	.9	.9	.9	.9	1.0	1.0	.0	.0	.0
67	.7	.8	.8	.8	.8	.9	.9	.9	.9	1.0	.0	.0	.0	.1	.1
68	.8	.8	.8	.9	.9	.9	.9	1.0	1.0	.0	.0	.1	.1	.1	.1
69	.8	.8	.9	.9	.9	1.0	1.0	.0	.0	.1	.1	.1	.2	.2	.2
70	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.1	1.1	1.1	1.2	1.2	1.2	1.2	1.3

TABLE III — (*Continued*)

LATITUDE CORRECTION (a_2)

	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74
	120	119	118	117	116	115	114	113	112	111	110	109	108	107	106
	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254
	300	299	298	297	296	295	294	293	292	291	290	289	288	287	286
$a + a_1$	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1
6	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
7	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
8	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
9	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
10	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
11	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
12	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
13	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	1	.1	.1	.1	.1
14	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
15	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2
16	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2
17	.1	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
18	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
19	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
20	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
21	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
22	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
23	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
24	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.3	.3	.3	.3
25	.2	.2	.2	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3	.3
26	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
27	.2	.2	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
28	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
29	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
30	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
31	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
32	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.4	.4	.4	.4
33	.3	.3	.3	.3	.3	.3	.3	.3	.4	.4	.4	.4	.4	.4	.4
34	.3	.3	.3	.3	.3	.3	.4	.4	.4	.4	.4	.4	.4	.4	.4
35	.3	.3	.3	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4
36	.3	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4
37	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4
38	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.5	.5
39	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.5	.5	.5	.5	.5
40	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5
41	.4	.4	.4	.4	.4	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5
42	.4	.4	.4	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5
43	.4	.4	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5
44	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.6	.6	.6
45	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.6	.6	.6	.6	.6
46	.5	.5	.5	.5	.5	.5	.5	.6	.6	.6	.6	.6	.6	.6	.6
47	.5	.5	.5	.5	.5	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6
48	.5	.5	.5	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6
49	.5	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.7	.7	.7
50	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7
51	.6	.6	.6	.6	.6	.6	.6	.7	.7	.7	.7	.7	.7	.7	.7
52	.6	.6	.6	.6	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7
53	.6	.6	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.8	.8	.8
54	.7	.7	.7	.7	.7	.7	.7	.7	.7	.8	.8	.8	.8	.8	.8
55	.7	.7	.7	.7	.7	.7	.8	.8	.8	.8	.8	.8	.8	.8	.8
56	.7	.7	.7	.7	.8	.8	.8	.8	.8	.8	.8	.8	.8	.9	.9
57	.7	.7	.8	.8	.8	.8	.8	.8	.8	.8	.9	.9	.9	.9	.9
58	.8	.8	.8	.8	.8	.8	.8	.8	.9	.9	.9	.9	.9	.9	.9
59	.8	.8	.8	.8	.8	.9	.9	.9	.9	.9	.9	.9	.9	1.0	1.0
60	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0
61	.9	.9	.9	.9	.9	.9	.9	1.0	1.0	.0	.0	.0	.0	.0	.0
62	.9	.9	.9	.9	1.0	1.0	1.0	.0	.0	.0	.0	.1	.1	.1	.1
63	.9	.9	1.0	1.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1
64	1.0	1.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2
65	.0	.0	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2
66	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3
67	.1	.1	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3	.4	.4
68	.2	.2	.2	.2	.3	.3	.3	.3	.3	.4	.4	.4	.4	.4	.4
69	.2	.3	.3	.3	.3	.3	.4	.4	.4	.4	.4	.5	.5	.5	.5
70	1.3	1.3	1.4	1.4	1.4	1.4	1.4	1.5	1.5	1.5	1.5	1.5	1.6	1.6	1.6

TABLE III — (*Continued*)

LATITUDE CORRECTION (a_2)

	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
	105	104	103	102	101	100	99	98	97	96	95	94	93	92	91	90
	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270
	285	284	283	282	281	280	279	278	277	276	275	274	273	272	271	270
$a + a_1$	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
1	0.0	0 0	0.0	0.0	0.0	0.0	0.0	0.0	0 0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
5	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
6	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
7	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
8	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
9	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
10	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
11	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
12	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
13	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
14	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
15	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
16	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
17	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
18	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
19	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
20	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
21	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
22	.2	.2	.2	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3	.3	.3
23	.2	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
24	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
25	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
26	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
27	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
28	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
29	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
30	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
31	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4
32	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4
33	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4
34	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4
35	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4
36	.4	.4	.4	.4	.4	.4	.4	.4	.5	.5	.5	.5	.5	.5	.5	.5
37	.4	.4	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5
38	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5
39	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5
40	0.5	0 5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
41	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5
42	.5	.5	.5	.5	.5	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6
43	.5	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6
44	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6
45	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6
46	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.7	.7	.7	.7
47	.6	.6	.6	.6	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7
48	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7
49	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7
50	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0 7	0.7	0.7	0.7	0.8	0.8	0.8
51	.7	.7	.7	.7	.7	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8
52	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8
53	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8
54	.8	.8	.8	.8	.8	.8	.8	.9	.9	.9	.9	.9	.9	.9	.9	.9
55	.8	.8	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9
56	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9
57	.9	.9	.9	.9	.9	.9	.9	1.0	1 0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
58	.9	.9	1.0	1.0	1.0	1.0	1.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
59	1.0	1.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
60	1.0	1.0	1.0	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
61	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
62	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
63	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
64	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
65	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.4	.4
66	.3	.3	.3	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4
67	.4	.4	.4	.4	.4	.4	.4	.5	.5	.5	.5	.5	.5	.5	.5	.5
68	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.6	.6	.6	.6	.6
69	.5	.5	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6
70	1.6	1.6	1.6	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7

TABLE IV

LONGITUDE CORRECTION (ϑ_2)

p	ϑ_2	p	ϑ_2
0°– 4°	0′.0	181°–184°	0′.0
5°– 14°	— .1	185°–194°	+ .1
15°– 26°	— .2	195°–206°	+ .2
27°– 63°	— .3	207°–243°	+ .3
64°– 75°	— .2	244°–255°	+ .2
76°– 85°	— .1	256°–265°	+ .1
86°– 90°	.0	266°–270°	.0
91°– 94°	.0	271°–274°	.0
95°–104°	+ .1	275°–284°	— .1
105°–116°	+ .2	285°–296°	— .2
117°–153°	+ .3	297°–333°	— .3
154°–165°	+ .2	334°–345°	— .2
166°–175°	+ .1	346°–355°	— .1
176°–180°	.0	356°–360°	.0

TABLE V

TRIGONOMETRICAL FUNCTIONS OF ANGLES IN DIFFERENT QUADRANTS

	$-A$	$90^\circ-A$	$90^\circ+A$	$180^\circ-A$	$180^\circ+A$	$270^\circ-A$	$270^\circ+A$	$360^\circ-A$
sin	$-\sin A$	$\cos A$	$\cos A$	$\sin A$	$-\sin A$	$-\cos A$	$-\cos A$	$-\sin A$
cos	$\cos A$	$\sin A$	$-\sin A$	$-\cos A$	$-\cos A$	$-\sin A$	$\sin A$	$\cos A$
tan	$-\tan A$	$\cot A$	$-\cot A$	$-\tan A$	$\tan A$	$\cot A$	$-\cot A$	$-\tan A$
cot	$-\cot A$	$\tan A$	$-\tan A$	$-\cot A$	$\cot A$	$\tan A$	$-\tan A$	$-\cot A$
sec	$\sec A$	$\operatorname{cosec} A$	$-\operatorname{cosec} A$	$-\sec A$	$-\sec A$	$-\operatorname{cosec} A$	$\operatorname{cosec} A$	$\sec A$
cosec	$-\operatorname{cosec} A$	$\sec A$	$\sec A$	$\operatorname{cosec} A$	$-\operatorname{cosec} A$	$-\sec A$	$-\sec A$	$-\operatorname{cosec} A$

TABLE VI

RAN, LOG COS *d*, AND SID. TIME OF 0^h G. C. T. FOR EACH DAY IN THE YEAR 1925

1925	RAN	log cos *d*	Sid. Time of 0^h G. C. T.			1925	RAN	log cos *d*	Sid. Time of 0^h G. C. T.		
	23° ′		h	m	s		23° ′		h	m	s
Jan. 1	41.4	8.2806	6	40	30.4	Mar. 1	25.7	8.2810	10	33	7.2
2	41.1	8.2806	6	44	27.0	2	25.5	8.2810	10	37	3.7
3	40.9	8.2806	6	48	23.5	3	25.3	8.2810	10	41	0.3
4	40.6	8.2806	6	52	20.1	4	25.1	8.2811	10	44	56.8
5	40.4	8.2806	6	56	16.6	5	24.9	8.2811	10	48	53.4
6	40.1	8.2806	7	0	13.2	6	24.7	8.2811	10	52	49.9
7	39.9	8.2806	7	4	9.7	7	24.5	8.2811	10	56	46.5
8	39.6	8.2805	7	8	6.3	8	24.3	8.2812	11	0	43.0
9	39.3	8.2805	7	12	2.8	9	24.1	8.2812	11	4	39.6
10	39.0	8.2805	7	15	59.4	10	23.9	8.2812	11	8	36.1
11	38.7	8.2805	7	19	56.0	11	23.7	8.2812	11	12	32.7
12	38.4	8.2805	7	23	52.5	12	23.6	8.2813	11	16	29.2
13	38.1	8.2805	7	27	49.1	13	23.4	8.2813	11	20	25.8
14	37.8	8.2805	7	31	45.6	14	23.3	8.2813	11	24	22.3
15	37.5	8.2805	7	35	42.2	15	23.2	8.2814	11	28	18.9
16	37.2	8.2805	7	39	38.8	16	23.1	8.2814	11	32	15.4
17	36.9	8.2805	7	43	35.3	17	23.0	8.2814	11	36	12.0
18	36.6	8.2805	7	47	31.9	18	22.9	8.2815	11	40	8.5
19	36.4	8.2805	7	51	28.4	19	22.8	8.2815	11	44	5.1
20	36.1	8.2805	7	55	25.0	20	22.6	8.2815	11	48	1.6
21	35.9	8.2805	7	59	21.5	21	22.5	8.2815	11	51	58.2
22	35.6	8.2805	8	3	18.1	22	22.3	8.2816	11	55	54.8
23	35.3	8.2805	8	7	14.6	23	22.2	8.2816	11	59	51.3
24	35.0	8.2805	8	11	11.2	24	22.1	8.2816	12	3	47.9
25	34.7	8.2805	8	15	7.8	25	22.0	8.2817	12	7	44.4
26	34.4	8.2805	8	19	4.3	26	21.9	8.2817	12	11	41.0
27	34.0	8.2805	8	23	0.9	27	21.8	8.2818	12	15	37.5
28	33.7	8.2805	8	26	57.4	28	21.8	8.2818	12	19	34.1
29	33.4	8.2805	8	30	54.0	29	21.7	8.2818	12	23	30.6
30	33.2	8.2805	8	34	50.5	30	21.7	8.2819	12	27	27.2
31	32.9	8.2805	8	38	47.1	31	21.6	8.2819	12	31	23.7
Feb. 1	32.6	8.2805	8	42	43.6	Apr. 1	21.6	8.2819	12	35	20.3
2	32.4	8.2805	8	46	40.2	2	21.5	8.2820	12	39	16.8
3	32.1	8.2805	8	50	36.8	3	21.5	8.2820	12	43	13.4
4	31.9	8.2805	8	54	33.3	4	21.4	8.2820	12	47	9.9
5	31.6	8.2805	8	58	29.9	5	21.3	8.2821	12	51	6.5
6	31.3	8.2806	9	2	26.4	6	21.3	8.2821	12	55	3.0
7	31.0	8.2806	9	6	23.0	7	21.2	8.2821	12	58	59.6
8	30.7	8.2806	9	10	19.5	8	21.2	8.2822	13	2	56.1
9	30.4	8.2806	9	14	16.1	9	21.2	8.2822	13	6	52.7
10	30.2	8.2806	9	18	12.6	10	21.2	8.2822	13	10	49.2
11	29.9	8.2806	9	22	9.2	11	21.2	8.2823	13	14	45.8
12	29.6	8.2806	9	26	5.8	12	21.3	8.2823	13	18	42.4
13	29.3	8.2807	9	30	2.3	13	21.3	8.2823	13	22	38.9
14	29.1	8.2807	9	33	58.9	14	21.3	8.2824	13	26	35.5
15	28.8	8.2807	9	37	55.4	15	21.4	8.2824	13	30	32.0
16	28.6	8.2807	9	41	52.0	16	21.4	8.2824	13	34	28.6
17	28.4	8.2807	9	45	48.5	17	21.4	8.2825	13	38	25.1
18	28.2	8.2807	9	49	45.1	18	21.4	8.2825	13	42	21.7
19	28.0	8.2808	9	53	41.6	19	21.4	8.2825	13	46	18.2
20	27.7	8.2808	9	57	38.2	20	21.4	8.2826	13	50	14.8
21	27.5	8.2808	10	1	34.7	21	21.4	8.2826	13	54	11.3
22	27.2	8.2808	10	5	31.3	22	21.5	8.2826	13	58	7.9
23	26.9	8.2808	10	9	27.8	23	21.6	8.2827	14	2	4.4
24	26.7	8.2809	10	13	24.4	24	21.7	8.2827	14	6	1.0
25	26.5	8.2809	10	17	20.9	25	21.8	8.2827	14	9	57.5
26	26.2	8.2809	10	21	17.5	26	21.9	8.2828	14	13	54.1
27	26.0	8.2809	10	25	14.0	27	22.0	8.2828	14	17	50.6
28	25.8	8.2810	10	29	10.6	28	22.1	8.2828	14	21	47.2
						29	22.2	8.2829	14	25	43.8
						30	22.2	8.2829	14	29	40.3

TABLE VI—(*Continued*)

RAN, LOG COS *d*, AND SID. TIME OF 0^h G. C. T. FOR EACH DAY IN THE YEAR 1925

1925	RAN	log cos *d*	Sid. Time of 0^h G. C. T.			1925	RAN	log cos *d*	Sid. Time of 0^h G. C. T.		
	23° ′		h	m	s		23° ′		h	m	s
May 1	22.3	8.2829	14	33	36.9	Jul. 1	35.1	8.2840	18	34	6.8
2	22.4	8.2830	14	37	33.4	2	35.4	8.2840	18	38	3.4
3	22.5	8.2830	14	41	30.0	3	35.7	8.2840	18	41	59.9
4	22.6	8.2830	14	45	26.5	4	36.0	8.2840	18	45	56.5
5	22.6	8.2830	14	49	23.1	5	36.3	8.2840	18	49	53.0
6	22.8	8.2831	14	53	19.6	6	36.6	8.2840	18	53	49.6
7	22.9	8.2831	14	57	16.2	7	36.9	8.2840	18	57	46.1
8	23.1	8.2831	15	1	12.8	8	37.2	8.2840	19	1	42.7
9	23.2	8.2832	15	5	9.3	9	37.4	8.2840	19	5	39.2
10	23.4	8.2832	15	9	5.9	10	37.7	8.2840	19	9	35.8
11	23.6	8.2832	15	13	2.4	11	37.9	8.2840	19	13	32.4
12	23.8	8.2832	15	16	59.0	12	38.2	8.2840	19	17	28.9
13	23.9	8.2833	15	20	55.5	13	38.5	8.2840	19	21	25.5
14	24.0	8.2833	15	24	52.1	14	38.8	8.2839	19	25	22.0
15	24.2	8.2833	15	28	48.6	15	39.1	8.2839	19	29	18.6
16	24.3	8.2833	15	32	45.2	16	39.4	8.2839	19	33	15.2
17	24.4	8.2834	15	36	41.7	17	39.7	8.2839	19	37	11.7
18	24.6	8.2834	15	40	38.3	18	40.0	8.2839	19	41	8.3
19	24.8	8.2834	15	44	34.9	19	40.3	8.2839	19	45	4.8
20	25.0	8.2834	15	48	31.4	20	40.6	8.2839	19	49	1.4
21	25.2	8.2835	15	52	28.0	21	40.8	8.2839	19	52	57.9
22	25.4	8.2835	15	56	24.5	22	41.1	8.2839	19	56	54.5
23	25.6	8.2835	16	0	21.1	23	41.3	8.2839	20	0	51.0
24	25.8	8.2835	16	4	17.6	24	41.6	8.2838	20	4	47.6
25	26.0	8.2836	16	8	14.2	25	41.8	8.2838	20	8	44.2
26	26.2	8.2836	16	12	10.8	26	42.1	8.2838	20	12	40.7
27	26.4	8.2836	16	16	7.3	27	42.3	8.2838	20	16	37.3
28	26.6	8.2836	16	20	3.9	28	42.6	8.2838	20	20	33.8
29	26.8	8.2836	16	24	0.4	29	42.9	8.2838	20	24	30.4
30	27.0	8.2837	16	27	57.0	30	43.2	8.2838	20	28	26.9
31	27.2	8.2837	16	31	53.5	31	43.5	8.2838	20	32	23.5
Jun. 1	27.4	8.2837	16	35	50.1	Aug. 1	43.8	8.2837	20	36	20.0
2	27.6	8.2837	16	39	46.6	2	44.1	8.2837	20	40	16.6
3	27.8	8.2837	16	43	43.2	3	44.4	8.2837	20	44	13.2
4	28.1	8.2838	16	47	39.8	4	44.7	8.2837	20	48	9.7
5	28.3	8.2838	16	51	36.3	5	44.9	8.2836	20	52	6.3
6	28.6	8.2838	16	55	32.9	6	45.1	8.2836	20	56	2.8
7	28.9	8.2838	16	59	29.4	7	45.4	8.2836	20	59	59.4
8	29.2	8.2838	17	3	26.0	8	45.6	8.2836	21	3	55.9
9	29.4	8.2838	17	7	22.5	9	45.8	8.2836	21	7	52.5
10	29.6	8.2838	17	11	19.1	10	46.1	8.2836	21	11	49.0
11	29.9	8.2838	17	15	15.7	11	46.4	8.2835	21	15	45.6
12	30.1	8.2839	17	19	12.2	12	46.7	8.2835	21	19	42.2
13	30.3	8.2839	17	23	8.8	13	46.9	8.2835	21	23	38.7
14	30.5	8.2839	17	27	5.3	14	47.2	8.2835	21	27	35.3
15	30.8	8.2839	17	31	1.9	15	47.5	8.2834	21	31	31.8
16	31.0	8.2839	17	34	58.4	16	47.7	8.2834	21	35	28.4
17	31.3	8.2839	17	38	55.0	17	48.0	8.2834	21	39	24.9
18	31.6	8.2839	17	42	51.6	18	48.2	8.2834	21	43	21.5
19	31.9	8.2839	17	46	48.1	19	48.4	8.2833	21	47	18.0
20	32.2	8.2839	17	50	44.7	20	48.6	8.2833	21	51	14.6
21	32.5	8.2840	17	54	41.2	21	48.8	8.2833	21	55	11.1
22	32.7	8.2840	17	58	37.8	22	49.0	8.2833	21	59	7.7
23	33.0	8.2840	18	2	34.3	23	49.2	8.2832	22	3	4.2
24	33.3	8.2840	18	6	30.9	24	49.5	8.2832	22	7	0.8
25	33.5	8.2840	18	10	27.5	25	49.7	8.2832	22	10	57.4
26	33.8	8.2840	18	14	24.0	26	50.0	8.2832	22	14	53.9
27	34.0	8.2840	18	18	20.6	27	50.2	8.2831	22	18	50.5
28	34.2	8.2840	18	22	17.1	28	50.5	8.2831	22	22	47.0
29	34.5	8.2840	18	26	13.7	29	50.7	8.2831	22	26	43.6
30	34.8	8.2840	18	30	10.2	30	50.9	8.2830	22	30	40.1
						31	51.1	8.2830	22	34	36.7

TABLE VI—(*Continued*)

RAN, LOG COS *d*, AND SID. TIME OF 0^h G. C. T. FOR EACH DAY IN THE YEAR 1925

1925	RAN	log cos *d*	Sid. Time of 0^h G. C. T.			1925	RAN	log cos *d*	Sid. Time of 0^h G. C. T.		
	23° ′		h	m	s		23° ′		h	m	s
Sep. 1	51.3	8.2830	22	38	33.2	Nov. 1	57.0	8.2805	2	39	2.9
2	51.5	8.2829	22	42	29.8	2	57.0	8.2805	2	42	59.5
3	51.7	8.2829	22	46	26.3	3	57.0	8.2804	2	46	56.0
4	51.8	8.2829	22	50	22.9	4	57.0	8.2804	2	50	52.6
5	52.0	8.2828	22	54	19.4	5	56.9	8.2804	2	54	49.2
6	52.2	8.2828	22	58	16.0	6	56.9	8.2803	2	58	45.7
7	52.4	8.2828	23	2	12.5	7	56.8	8.2803	3	2	42.3
8	52.6	8.2827	23	6	9.1	8	56.7	8.2802	3	6	38.8
9	52.8	8.2827	23	10	5.6	9	56.6	8.2802	3	10	35.4
10	53.1	8.2827	23	14	2.2	10	56.5	8.2802	3	14	31.9
11	53.2	8.2826	23	17	58.8	11	56.4	8.2801	3	18	28.5
12	53.4	8.2826	23	21	55.3	12	56.3	8.2801	3	22	25.0
13	53.6	8.2825	23	25	51.8	13	56.2	8.2800	3	26	21.6
14	53.8	8.2825	23	29	48.4	14	56.1	8.2800	3	30	18.2
15	53.9	8.2825	23	33	45.0	15	56.0	8.2800	3	34	14.7
16	54.0	8.2824	23	37	41.5	16	56.0	8.2799	3	38	11.3
17	54.2	8.2824	23	41	38.1	17	55.9	8.2799	3	42	7.8
18	54.3	8.2824	23	45	34.6	18	55.8	8.2799	3	46	4.4
19	54.4	8.2823	23	49	31.2	19	55.7	8.2798	3	50	0.9
20	54.5	8.2823	23	53	27.7	20	55.6	8.2798	3	53	57.5
21	54.7	8.2823	23	57	24.3	21	55.4	8.2797	3	57	54.0
22	54.8	8.2822	0	1	20.8	22	55.3	8.2797	4	1	50.6
23	55.0	8.2822	0	5	17.4	23	55.1	8.2797	4	5	47.2
24	55.2	8.2821	0	9	13.9	24	54.9	8.2796	4	9	43.7
25	55.3	8.2821	0	13	10.5	25	54.8	8.2796	4	13	40.3
26	55.5	8.2821	0	17	7.0	26	54.6	8.2796	4	17	36.8
27	55.6	8.2820	0	21	3.6	27	54.5	8.2795	4	21	33.4
28	55.7	8.2820	0	25	0.1	28	54.3	8.2795	4	25	29.9
29	55.8	8.2819	0	28	56.7	29	54.2	8.2795	4	29	26.5
30	55.9	8.2819	0	32	53.2	30	54.1	8.2794	4	33	23.0
Oct. 1	55.9	8.2819	0	36	49.8	Dec. 1	53.9	8.2794	4	37	19.6
2	56.0	8.2818	0	40	46.3	2	53.8	8.2794	4	41	16.2
3	56.1	8.2818	0	44	42.9	3	53.6	8.2793	4	45	12.7
4	56.2	8.2817	0	48	39.4	4	53.4	8.2793	4	49	9.3
5	56.3	8.2817	0	52	36.0	5	53.2	8.2793	4	53	5.8
6	56.4	8.2817	0	56	32.6	6	53.0	8.2792	4	57	2.4
7	56.5	8.2816	1	0	29.1	7	52.8	8.2792	5	0	59.0
8	56.6	8.2816	1	4	25.7	8	52.5	8.2792	5	4	55.5
9	56.7	8.2815	1	8	22.2	9	52.3	8.2791	5	8	52.1
10	56.8	8.2815	1	12	18.8	10	52.1	8.2791	5	12	48.6
11	56.9	8.2814	1	16	15.3	11	51.9	8.2791	5	16	45.2
12	56.9	8.2814	1	20	11.9	12	51.7	8.2791	5	20	41.7
13	56.9	8.2814	1	24	8.4	13	51.5	8.2790	5	24	38.3
14	56.9	8.2813	1	28	5.0	14	51.3	8.2790	5	28	34.9
15	57.0	8.2813	1	32	1.5	15	51.1	8.2790	5	32	31.4
16	57.0	8.2812	1	35	58.1	16	50.9	8.2789	5	36	28.0
17	57.0	8.2812	1	39	54.6	17	50.7	8.2789	5	40	24.5
18	57.1	8.2811	1	43	51.2	18	50.5	8.2789	5	44	21.1
19	57.1	8.2811	1	47	47.7	19	50.2	8.2789	5	48	17.6
20	57.2	8.2810	1	51	44.3	20	49.9	8.2788	5	52	14.2
21	57.2	8.2810	1	55	40.8	21	49.6	8.2788	5	56	10.8
22	57.3	8.2809	1	59	37.4	22	49.4	8.2788	6	0	7.3
23	57.3	8.2809	2	3	34.0	23	49.1	8.2788	6	4	3.9
24	57.3	8.2809	2	7	30.5	24	48.9	8.2788	6	8	0.4
25	57.3	8.2808	2	11	27.1	25	48.6	8.2787	6	11	57.0
26	57.2	8.2808	2	15	23.6	26	48.4	8.2787	6	15	53.6
27	57.2	8.2807	2	19	20.2	27	48.2	8.2787	6	19	50.1
28	57.1	8.2807	2	23	16.7	28	48.0	8.2787	6	23	46.7
29	57.1	8.2806	2	27	13.3	29	47.7	8.2787	6	27	43.2
30	57.1	8.2806	2	31	9.8	30	47.4	8.2786	6	31	39.8
31	57.0	8.2806	2	35	6.4	31	47.2	8.2786	6	35	36.3

TABLE VII

VALUES OF *c*, LOG COSEC *c*, AND RAN + *n* FOR 27 SELECTED STARS (1925), AS FOLLOWS:

Name	Magnitude	R. A.		Dec.		Page
		h	m	°	′	
Alpha Andromedae (Alpheratz)	2.2	0	5	28	41	75
Beta Cassiopeiae (Caph)	2.4	0	5	58	44	75
Beta Ceti (Daneb Kaitos)	2.2	0	40	—18	24	75
Alpha Arietis (Hamal)	2.2	2	3	23	7	76
Alpha Persei (Mirfak)	1.9	3	19	49	36	76
Alpha Tauri (Aldebaran)	1.1	4	32	16	22	76
Beta Orionis (Rigel)	0.3	5	11	— 8	17	77
Alpha Aurigae (Capella)	0.2	5	11	45	55	77
Alpha Orionis (Betelgeux)	1.0	5	51	7	24	77
Alpha Canis Majoris (Sirius)	—1.6	6	42	—16	37	78
Alpha Canis Minoris (Procyon)	0.5	7	35	5	27	78
Beta Geminorum (Pollux)	1.2	7	41	28	13	78
Alpha Hydrae (Alphard)	2.2	9	24	— 8	20	79
Alpha Leonis (Regulus)	1.3	10	4	12	20	79
Alpha Ursae Majoris (Dubhe)	2.0	10	59	62	9	79
Beta Leonis (Denebola)	2.2	11	45	14	59	80
Alpha Virginis (Spica)	1.2	13	21	—10	46	80
Eta Ursae Majoris (Alkaid)	1.9	13	45	49	41	80
Alpha Boötis (Arcturus)	0.2	14	12	19	34	81
Alpha Coronae Borealis (Alphecca)	2.3	15	32	26	58	81
Alpha Ophiuchi (Rasalhague)	2.1	17	31	12	37	81
Gamma Draconis (Etamin)	2.4	17	55	51	30	82
Alpha Lyrae (Vega)	0.1	18	34	38	43	82
Alpha Aquilae (Altair)	0.9	19	47	8	40	82
Alpha Cygni (Deneb)	1.3	20	39	45	1	83
Epsilon Pegasi (Enif)	2.5	21	41	9	32	83
Alpha Pegasi (Markab)	2.6	23	1	14	48	83

TABLE VII—(*Continued*)

VALUES OF c, LOG COSEC c, AND RAN + n FOR 27 SELECTED STARS (1925)

	Alpha Androm. (Alpheratz)			Beta Cassiop. (Caph)			Beta Ceti (Daneb Kaitos)		
	c 60°	log cosec c	RAN+n 180°	c 30°	log cosec c	RAN+n 180°	c 107°	log cosec c	RAN+n 190°
1925	′		′	′		′	′		′
Jan. 1	18.8	.06110	53.3	15.1	.29774	34.8	20.4	.02020	2.2
11	18.8	.06110	53.3	15.1	.29774	34.8	20.4	.02020	2.1
21	18.9	.06110	53.3	15.2	.29772	34.8	20.4	.02020	2.1
31	18.9	.06110	53.3	15.2	.29772	34.8	20.4	.02020	2.0
Feb. 10	18.8	.06110	53.3	15.2	.29772	34.8	20.3	.02019	2.0
20	18.8	.06110	53.3	15.2	.29772	34.8	20.3	.02019	1.9
Mar. 2	18.8	.06110	53.3	15.2	.29772	34.8	20.2	.02019	1.9
12	18.8	.06110	53.3	15.2	.29772	34.8	20.2	.02019	1.9
22	18.8	.06110	53.3	15.1	.29774	34.8	20.1	.02018	1.9
Apr. 1	18.7	.06111	53.3	15.1	.29774	34.8	20.0	.02018	1.9
11	18.7	.06111	53.3	15.1	.29774	34.9	19.9	.02018	1.9
21	18.6	.06112	53.4	15.1	.29774	34.9	19.8	.02017	2.0
May 1	18.6	.06112	53.4	15.1	.29774	34.9	19.8	.02017	2.0
11	18.6	.06112	53.4	15.1	.29774	34.9	19.7	.02017	2.1
21	18.5	.06112	53.5	15.1	.29774	35.0	19.6	.02016	2.1
31	18.5	.06112	53.5	15.1	.29774	35.0	19.6	.02016	2.2
June 10	18.5	.06112	53.6	15.0	.29776	35.1	19.5	.02016	2.3
20	18.5	.06112	53.6	15.0	.29776	35.1	19.5	.02016	2.4
30	18.4	.06113	53.7	15.0	.29776	35.1	19.4	.02016	2.5
July 10	18.4	.06113	53.8	15.0	.29776	35.2	19.4	.02016	2.6
20	18.4	.06113	53.8	15.0	.29776	35.2	19.4	.02016	2.7
30	18.4	.06113	53.9	15.0	.29776	35.2	19.4	.02016	2.8
Aug. 9	18.4	.06113	53.9	15.0	.29776	35.3	19.4	.02016	2.9
19	18.4	.06113	53.9	15.0	.29776	35.3	19.5	.02016	2.9
29	18.4	.06113	54.0	15.0	.29776	35.3	19.5	.02016	3.0
Sep. 8	18.5	.06112	54.0	15.0	.29776	35.3	19.6	.02016	3.1
18	18.5	.06112	54.0	15.0	.29776	35.4	19.7	.02017	3.1
28	18.5	.06112	54.0	15.0	.29776	35.4	19.7	.02017	3.1
Oct. 8	18.6	.06112	54.0	15.0	.29776	35.4	19.8	.02017	3.1
17	18.6	.06112	54.0	15.0	.29776	35.4	19.9	.02018	3.1
27	18.6	.06112	54.0	15.1	.29774	35.4	20.0	.02018	3.1
Nov. 6	18.7	.06111	54.0	15.1	.29774	35.4	20.1	.02018	3.1
16	18.7	.06111	54.0	15.1	.29774	35.4	20.1	.02018	3.1
26	18.7	.06111	54.0	15.1	.29774	35.4	20.2	.02019	3.1
Dec. 6	18.8	.06110	54.0	15.1	.29774	35.5	20.3	.02019	3.0
16	18.8	.06110	54.0	15.1	.29774	35.5	20.3	.02019	3.0
26	18.8	.06110	54.0	15.1	.29774	35.5	20.3	.02019	2.9
1926 Jan. 5	18.8	.06110	54.0	15.1	.29774	35.5	20.4	.02020	2.9

TABLE VII—(*Continued*)

VALUES OF c, LOG COSEC c, AND RAN + n FOR 27 SELECTED STARS (1925)

	Alpha Arietis (Hamal)			Alpha Persei (Mirfak)			Alpha Tauri (Aldebaran)		
	c	log cosec c	RAN+n	c	log cosec c	RAN+n	c	log cosec c	RAN+n
	65°		**210°**	**39°**		**230°**	**72°**		**248°**
1925	′		′	′		′	′		′
Jan. 1	48.4	.03993	47.6	25.4	.19720	19.4	51.6	.01973	8.1
11	48.5	.03992	47.6	25.5	.19718	19.4	51.7	.01972	8.1
21	48.5	.03992	47.6	25.5	.19718	19.4	51.7	.01972	8.1
31	48.5	.03992	47.6	25.5	.19718	19.4	51.7	.01972	8.1
Feb. 10	48.5	.03992	47.6	25.5	.19718	19.4	51.8	.01972	8.1
20	48.5	.03992	47.6	25.5	.19718	19.4	51.8	.01972	8.1
Mar. 2	48.5	.03992	47.5	25.5	.19718	19.4	51.8	.01972	8.0
12	48.5	.03992	47.5	25.5	.19718	19.3	51.8	.01972	8.0
22	48.4	.03993	47.5	25.5	.19718	19.3	51.8	.01972	8.0
Apr. 1	48.4	.03993	47.5	25.5	.19718	19.3	51.8	.01972	7.9
11	48.3	.03993	47.5	25.5	.19718	19.3	51.7	.01972	7.9
21	48.3	.03993	47.5	25.4	.19720	19.4	51.7	.01972	7.9
May 1	48.2	.03994	47.5	25.4	.19720	19.4	51.6	.01973	7.9
11	48.2	.03994	47.6	25.4	.19720	19.4	51.6	.01973	7.9
21	48.1	.03994	47.6	25.4	.19720	19.4	51.5	.01973	7.9
31	48.1	.03994	47.7	25.4	.19720	19.4	51.5	.01973	7.9
June 10	48.1	.03994	47.7	25.3	.19721	19.5	51.4	.01973	8.0
20	48.0	.03995	47.8	25.3	.19721	19.5	51.4	.01973	8.0
30	48.0	.03995	47.8	25.3	.19721	19.5	51.3	.01974	8.0
July 10	48.0	.03995	47.9	25.3	.19721	19.6	51.2	.01974	8.1
20	47.9	.03996	47.9	25.2	.19723	19.6	51.2	.01974	8.1
30	47.9	.03996	48.0	25.2	.19723	19.7	51.2	.01974	8.2
Aug. 9	47.9	.03996	48.0	25.2	.19723	19.7	51.1	.01975	8.3
19	47.9	.03996	48.1	25.2	.19723	19.7	51.1	.01975	8.3
29	47.9	.03996	48.1	25.2	.19723	19.8	51.1	.01975	8.4
Sep. 8	47.9	.03996	48.2	25.2	.19723	19.8	51.1	.01975	8.4
18	48.0	.03995	48.2	25.2	.19723	19.8	51.1	.01975	8.5
28	48.0	.03995	48.2	25.2	.19723	19.9	51.1	.01975	8.5
Oct. 8	48.0	.03995	48.3	25.2	.19723	19.9	51.1	.01975	8.6
17	48.1	.03994	48.3	25.2	.19723	19.9	51.2	.01974	8.6
27	48.1	.03994	48.3	25.3	.19721	19.9	51.2	.01974	8.7
Nov. 6	48.2	.03994	48.3	25.3	.19721	20.0	51.3	.01974	8.7
16	48.2	.03994	48.3	25.3	.19721	20.0	51.3	.01974	8.8
26	48.3	.03993	48.4	25.3	.19721	20.0	51.4	.01973	8.8
Dec. 6	48.3	.03993	48.4	25.4	.19720	20.0	51.4	.01973	8.8
16	48.4	.03993	48.4	25.4	.19720	20.0	51.5	.01973	8.8
26	48.4	.03993	48.4	25.4	.19720	20.1	51.6	.01973	8.8
1926									
Jan. 5	48.4	.03993	48.3	25.4	.19720	20.1	51.6	.01973	8.8

TABLE VII—(*Continued*)

VALUES OF *c*, LOG COSEC *c*, AND RAN + *n* FOR 27 SELECTED STARS (1925)

	Beta Orionis (Rigel)			Alpha Aurigae (Capella)			Alpha Orionis (Betelgeux)		
	c	log cosec *c*	RAN+*n*	*c*	log cosec *c*	RAN+*n*	*c*	log cosec *c*	RAN+*n*
	97°		**257°**	**43°**		**258°**	**82°**		**267°**
1925	′		′	′		′	′		′
Jan. 1	38.8	.00388	36.7	26.6	.16264	43.2	7.9	.00411	54.7
11	38.9	.00388	36.7	26.6	.16264	43.3	7.9	.00411	54.7
21	39.0	.00388	36.7	26.7	.16263	43.3	8.0	.00411	54.7
31	39.0	.00388	36.7	26.7	.16263	43.3	8.1	.00411	54.7
Feb. 10	39.1	.00388	36.6	26.7	.16263	43.3	8.1	.00411	54.7
20	39.1	.00388	36.6	26.7	.16263	43.3	8.1	.00411	54.7
Mar. 2	39.1	.00388	36.5	26.7	.16263	43.2	8.2	.00411	54.6
12	39.1	.00388	36.5	26.7	.16263	43.2	8.2	.00411	54.6
22	39.1	.00388	36.4	26.7	.16263	43.2	8.2	.00411	54.6
Apr. 1	39.1	.00388	36.3	26.7	.16263	43.2	8.2	.00411	54.5
11	39.1	.00388	36.3	26.7	.16263	43.2	8.2	.00411	54.5
21	39.0	.00388	36.3	26.7	.16263	43.2	8.1	.00411	54.5
May 1	39.0	.00388	36.2	26.7	.16263	43.2	8.1	.00411	54.4
11	38.9	.00388	36.2	26.7	.16263	43.2	8.0	.00411	54.4
21	38.8	.00388	36.2	26.6	.16264	43.2	8.0	.00411	54.4
31	38.7	.00388	36.2	26.6	.16264	43.2	7.9	.00411	54.4
June 10	38.7	.00388	36.3	26.6	.16264	43.3	7.8	.00411	54.4
20	38.6	.00388	36.3	26.5	.16266	43.3	7.8	.00411	54.5
30	38.5	.00388	36.3	26.5	.16266	43.3	7.7	.00411	54.5
July 10	38.4	.00387	36.4	26.5	.16266	43.4	7.6	.00411	54.5
20	38.3	.00387	36.4	26.5	.16266	43.4	7.6	.00411	54.6
30	38.3	.00387	36.5	26.4	.16267	43.4	7.5	.00412	54.6
Aug. 9	38.2	.00387	36.6	26.4	.16267	43.5	7.5	.00412	54.7
19	38.2	.00387	36.7	26.4	.16267	43.5	7.4	.00412	54.7
29	38.2	.00387	36.7	26.4	.16267	43.5	7.4	.00412	54.8
Sep. 8	38.2	.00387	36.8	26.4	.16267	43.6	7.4	.00412	54.9
18	38.2	.00387	36.9	26.4	.16267	43.6	7.4	.00412	54.9
28	38.2	.00387	37.0	26.4	.16267	43.6	7.4	.00412	55.0
Oct. 8	38.2	.00387	37.0	26.4	.16267	43.7	7.4	.00412	55.0
17	38.2	.00387	37.1	26.4	.16267	43.7	7.4	.00412	55.1
27	38.3	.00387	37.2	26.4	.16267	43.8	7.5	.00412	55.2
Nov. 6	38.4	.00387	37.2	26.5	.16266	43.8	7.5	.00412	55.2
16	38.4	.00387	37.3	26.5	.16266	43.8	7.6	.00411	55.3
26	38.5	.00388	37.3	26.5	.16266	43.9	7.6	.00411	55.3
Dec. 6	38.6	.00388	37.4	26.5	.16266	43.9	7.7	.00411	55.4
16	38.7	.00388	37.4	26.6	.16264	43.9	7.8	.00411	55.4
26	38.8	.00388	37.4	26.6	.16264	43.9	7.8	.00411	55.4
1926 Jan. 5	38.9	.00388	37.4	26.6	.16264	43.9	7.9	.00411	55.4

TABLE VII—(*Continued*)

VALUES OF *c*, LOG COSEC *c*, AND RAN + *n* FOR 27 SELECTED STARS (1925)

	Alpha Can. Maj. (Sirius)			Alpha Can. Min. (Procyon)			Beta Gemin. (Pollux)		
	c **106°**	log cosec *c*	RAN+*n* **280°**	*c* **84°**	log cosec *c*	RAN+*n* **293°**	*c* **61°**	log cosec *c*	RAN+*n* **295°**
1925	′		′	′		′	′		′
Jan. 1	21.7	.01795	8.9	35.2	.00194	57.0	49.7	.05476	46.2
11	21.8	.01795	9.0	35.3	.00194	57.0	49.7	.05476	46.3
21	21.9	.01796	9.0	35.4	.00194	57.1	49.8	.05475	46.3
31	22.0	.01796	8.9	35.5	.00194	57.1	49.8	.05475	46.3
Feb. 10	22.0	.01796	8.9	35.5	.00194	57.1	49.9	.05475	46.3
20	22.1	.01796	8.9	35.6	.00193	57.0	49.9	.05475	46.3
Mar. 2	22.2	.01797	8.8	35.6	.00193	57.0	49.9	.05475	46.3
12	22.2	.01797	8.7	35.7	.00193	57.0	49.9	.05475	46.3
22	22.2	.01797	8.7	35.7	.00193	57.0	50.0	.05474	46.2
Apr. 1	22.2	.01797	8.6	35.7	.00193	56.9	50.0	.05474	46.2
11	22.2	.01797	8.5	35.7	.00193	56.9	50.0	.05474	46.2
21	22.2	.01797	8.5	35.7	.00193	56.8	50.0	.05474	46.2
May 1	22.1	.01796	8.4	35.7	.00193	56.8	49.9	.05475	46.2
11	22.1	.01796	8.4	35.6	.00193	56.8	49.9	.05475	46.2
21	22.0	.01796	8.4	35.6	.00193	56.8	49.9	.05475	46.1
31	21.9	.01796	8.3	35.5	.00194	56.8	49.9	.05475	46.1
June 10	21.8	.01795	8.3	35.5	.00194	56.7	49.8	.05475	46.1
20	21.8	.01795	8.3	35.4	.00194	56.7	49.8	.05475	46.2
30	21.7	.01795	8.4	35.4	.00194	56.8	49.7	.05476	46.2
July 10	21.6	.01795	8.4	35.3	.00194	56.8	49.7	.05476	46.2
20	21.5	.01794	8.4	35.2	.00194	56.8	49.6	.05477	46.2
30	21.4	.01794	8.5	35.2	.00194	56.8	49.6	.05477	46.2
Aug. 9	21.3	.01794	8.5	35.1	.00194	56.9	49.5	.05478	46.3
19	21.3	.01794	8.6	35.0	.00194	56.9	49.5	.05478	46.3
29	21.2	.01794	8.7	35.0	.00194	57.0	49.5	.05478	46.3
Sep. 8	21.2	.01794	8.8	34.9	.00194	57.0	49.4	.05478	46.4
18	21.2	.01794	8.9	34.9	.00194	57.1	49.4	.05478	46.4
28	21.2	.01794	9.0	34.9	.00194	57.1	49.4	.05478	46.5
Oct. 8	21.2	.01794	9.0	34.9	.00194	57.2	49.4	.05478	46.5
17	21.2	.01794	9.1	34.9	.00194	57.3	49.4	.05478	46.6
27	21.2	.01794	9.2	34.9	.00194	57.3	49.4	.05478	46.6
Nov. 6	21.3	.01794	9.3	34.9	.00194	57.4	49.4	.05478	46.7
16	21.3	.01794	9.4	35.0	.00194	57.5	49.5	.05478	46.7
26	21.4	.01794	9.5	35.0	.00194	57.5	49.5	.05478	46.8
Dec. 6	21.5	.01794	9.5	35.1	.00194	57.6	49.5	.05478	46.8
16	21.6	.01795	9.6	35.1	.00194	57.7	49.6	.05477	46.9
26	21.7	.01795	9.6	35.2	.00194	57.7	49.6	.05477	46.9
1926 Jan. 5	21.8	.01795	9.6	35.3	.00194	57.7	49.7	.05476	46.9

TABLE VII—(*Continued*)

VALUES OF *c*, LOG COSEC *c*, AND RAN + *n* FOR 27 SELECTED STARS (1925)

	Alpha Hydrae (Alphard)			Alpha Leonis (Regulus)			Alpha Urs. Maj. (Dubhe)		
	c	log cosec *c*	RAN+*n*	*c*	log cosec *c*	RAN+*n*	*c*	log cosec *c*	RAN+*n*
	98°		**320°**	**78°**		**331°**	**28°**		**346°**
1925	′		′	′		′	′		′
Jan. 1	50.0	.00518	49.8	19.9	.00907	16.8	42.4	.31847	2.2
11	50.1	.00518	49.9	20.0	.00907	16.8	42.4	.31847	2.2
21	50.1	.00518	49.9	20.1	.00907	16.9	42.4	.31847	2.3
31	50.2	.00518	50.0	20.1	.00907	16.9	42.4	.31847	2.3
Feb. 10	50.3	.00519	50.0	20.2	.00906	16.9	42.4	.31847	2.3
20	50.4	.00519	50.0	20.2	.00906	17.0	42.4	.31847	2.3
Mar. 2	50.4	.00519	50.0	20.3	.00906	17.0	42.4	.31847	2.3
12	50.5	.00519	50.0	20.3	.00906	17.0	42.5	.31844	2.3
22	50.6	.00519	49.9	20.4	.00906	17.0	42.5	.31844	2.4
Apr. 1	50.6	.00519	49.9	20.4	.00906	17.0	42.5	.31844	2.4
11	50.6	.00519	49.9	20.4	.00906	16.9	42.5	.31844	2.4
21	50.7	.00519	49.8	20.5	.00906	16.9	42.5	.31844	2.4
May 1	50.7	.00519	49.8	20.5	.00906	16.9	42.5	.31844	2.4
11	50.7	.00519	49.7	20.5	.00906	16.9	42.5	.31844	2.4
21	50.6	.00519	49.7	20.5	.00906	16.8	42.5	.31844	2.4
31	50.6	.00519	49.7	20.4	.00906	16.8	42.5	.31844	2.4
June 10	50.6	.00519	49.6	20.4	.00906	16.8	42.4	.31847	2.4
20	50.5	.00519	49.6	20.4	.00906	16.8	42.4	.31847	2.4
30	50.4	.00519	49.6	20.3	.00906	16.8	42.4	.31847	2.4
July 10	50.4	.00519	49.6	20.3	.00906	16.8	42.4	.31847	2.5
20	50.3	.00519	49.6	20.2	.00906	16.8	42.4	.31847	2.5
30	50.2	.00518	49.6	20.2	.00906	16.8	42.4	.31847	2.5
Aug. 9	50.1	.00518	49.6	20.1	.00907	16.8	42.4	.31847	2.5
19	50.1	.00518	49.6	20.0	.00907	16.8	42.3	.31849	2.5
29	50.0	.00518	49.6	20.0	.00907	16.8	42.3	.31849	2.5
Sep. 8	49.9	.00518	49.7	19.9	.00907	16.8	42.3	.31849	2.5
18	49.9	.00518	49.7	19.9	.00907	16.9	42.3	.31849	2.6
28	49.8	.00518	49.8	19.8	.00907	16.9	42.3	.31849	2.6
Oct. 8	49.8	.00518	49.9	19.8	.00907	16.9	42.3	.31849	2.6
17	49.7	.00517	49.9	19.8	.00907	17.0	42.3	.31849	2.6
27	49.7	.00517	50.0	19.8	.00907	17.0	42.3	.31849	2.6
Nov. 6	49.7	.00517	50.1	19.8	.00907	17.1	42.3	.31849	2.7
16	49.7	.00517	50.2	19.8	.00907	17.2	42.3	.31849	2.7
26	49.8	.00518	50.3	19.8	.00907	17.2	42.3	.31849	2.7
Dec. 6	49.8	.00518	50.3	19.8	.00907	17.3	42.3	.31849	2.8
16	49.9	.00518	50.4	19.9	.00907	17.4	42.3	.31849	2.8
26	49.9	.00518	50.5	19.9	.00907	17.4	42.4	.31847	2.9
1926 Jan. 5	50.0	.00518	50.6	20.0	00907	17.5	42.4	.31847	2.9

TABLE VII—(*Continued*)

VALUES OF c, LOG COSEC c, AND RAN + n FOR 27 SELECTED STARS (1925)

	Beta Leonis (Denebola)			Alpha Virginis (Spica)			Eta Urs. Maj. (Alkaid)		
	c	log cosec c	RAN+n	c	log cosec c	RAN+n	c	log cosec c	RAN+n
	75°		**356°**	**101°**		**20°**	**41°**		**26°**
1925	′		′	′		′	′		′
Jan. 1	58.8	.01314	26.2	51.6	.00937	17.6	24.5	.17952	5.2
11	58.9	.01313	26.3	51.6	.00937	17.7	24.5	.17952	5.3
21	58.9	.01313	26.3	51.6	.00937	17.8	24.5	.17952	5.3
31	59.0	.01313	26.4	51.6	.00937	17.9	24.5	.17952	5.3
Feb. 10	59.0	.01313	26.4	51.7	.00937	17.9	24.5	.17952	5.4
20	59.1	.01313	26.5	51.8	.00938	18.0	24.5	.17952	5.4
Mar. 2	59.1	.01313	26.5	51.8	.00938	18.1	24.6	.17951	5.4
12	59.2	.01312	26.5	51.9	.00938	18.1	24.6	.17951	5.5
22	59.2	.01312	26.5	51.9	.00938	18.2	24.6	.17951	5.5
Apr. 1	59.3	.01312	26.5	52.0	.00938	18.2	24.6	.17951	5.5
11	59.3	.01312	26.5	52.1	.00938	18.2	24.6	.17951	5.5
21	59.3	.01312	26.5	52.1	.00938	18.2	24.6	.17951	5.5
May 1	59.3	.01312	26.5	52.2	.00939	18.2	24.6	.17951	5.6
11	59.4	.01312	26.5	52.2	.00939	18.2	24.6	.17951	5.6
21	59.4	.01312	26.5	52.2	.00939	18.2	24.6	.17951	5.6
31	59.4	.01312	26.5	52.3	.00939	18.2	24.6	.17951	5.6
June 10	59.3	.01312	26.5	52.3	.00939	18.2	24.6	.17951	5.6
20	59.3	.01312	26.4	52.3	.00939	18.1	24.6	.17951	5.6
30	59.3	.01312	26.4	52.3	.00939	18.1	24.6	.17951	5.6
July 10	59.3	.01312	26.4	52.3	.00939	18.1	24.6	.17951	5.6
20	59.2	.01312	26.4	52.3	.00939	18.0	24.6	.17951	5.6
30	59.2	.01312	26.4	52.2	.00939	18.0	24.6	.17951	5.6
Aug. 9	59.1	.01313	26.4	52.2	.00939	17.9	24.5	.17952	5.6
19	59.1	.01313	26.4	52.1	.00938	17.9	24.5	.17952	5.6
29	59.0	.01313	26.4	52.1	.00938	17.9	24.5	.17952	5.6
Sep. 8	59.0	.01313	26.4	52.0	.00938	17.8	24.5	.17952	5.6
18	58.9	.01313	26.4	52.0	.00938	17.8	24.5	.17952	5.6
28	58.9	.01313	26.4	51.9	.00938	17.8	24.5	.17952	5.6
Oct. 8	58.9	.01313	26.4	51.8	.00938	17.8	24.5	.17952	5.7
17	58.8	.01314	26.5	51.8	.00938	17.8	24.4	.17953	5.7
27	58.8	.01314	26.5	51.7	.00937	17.8	24.4	.17953	5.7
Nov. 6	58.8	.01314	26.5	51.7	.00937	17.9	24.4	.17953	5.7
16	58.8	.01314	26.6	51.6	.00937	17.9	24.4	.17953	5.7
26	58.8	.01314	26.7	51.6	.00937	18.0	24.4	.17953	5.8
Dec. 6	58.8	.01314	26.7	51.6	.00937	18.1	24.4	.17953	5.8
16	58.8	.01314	26.8	51.5	.00937	18.2	24.4	.17953	5.8
26	58.8	.01314	26.9	51.5	.00937	18.2	24.5	.17952	5.9
1926 Jan. 5	58.9	.01313	26.9	51.6	.00937	18.3	24.5	.17952	5.9

TABLE VII—(*Continued*)

VALUES OF c, LOG COSEC c, AND RAN + n FOR 27 SELECTED STARS (1925)

	Alpha Boötis (Arcturus)			Alpha Cor. Bor. (Alphecca)			Alpha Ophiuchi (Rasalhague)		
	c **71°**	log cosec c	RAN+n **32°**	c **63°**	log cosec c	RAN+n **52°**	c **77°**	log cosec c	RAN+n **82°**
1925	′		′	′		′	′		′
Jan. 1	30.4	.02302	59.6	59.4	.04638	36.4	56.8	.00968	39.0
11	30.4	.02302	59.7	59.4	.04638	36.4	56.8	.00968	39.0
21	30.4	.02302	59.7	59.4	.04638	36.5	56.8	.00968	39.1
31	30.5	.02302	59.8	59.4	.04638	36.5	56.8	.00968	39.1
Feb. 10	30.5	.02302	59.8	59.4	.04638	36.6	56.8	.00968	39.2
20	30.5	.02302	59.9	59.4	.04638	36.6	56.8	.00968	39.3
Mar. 2	30.5	.02302	59.9	59.4	.04638	36.7	56.8	.00968	39.3
12	30.6	.02302	60.0	59.5	.04637	36.7	56.8	.00968	39.4
22	30.6	.02302	60.0	59.5	.04637	36.8	56.8	.00968	39.4
Apr. 1	30.6	.02302	60.0	59.5	.04637	36.8	56.8	.00968	39.5
11	30.7	.02301	60.1	59.5	.04637	36.8	56.8	.00968	39.5
21	30.7	.02301	60.1	59.5	.04637	36.9	56.8	.00968	39.6
May 1	30.7	.02301	60.1	59.6	.04636	36.9	56.8	.00968	39.7
11	30.8	.02301	60.1	59.6	.04636	36.9	56.8	.00968	39.7
21	30.8	.02301	60.1	59.6	.04636	37.0	56.9	.00968	39.7
31	30.8	.02301	60.1	59.6	.04636	37.0	56.9	.00968	39.8
June 10	30.8	.02301	60.1	59.6	.04636	37.0	56.9	.00968	39.8
20	30.8	.02301	60.1	59.6	.04636	37.0	56.9	.00968	39.8
30	30.8	.02301	60.1	59.6	.04636	37.0	56.9	.00968	39.9
July 10	30.8	.02301	60.1	59.6	.04636	37.0	57.0	.00968	39.9
20	30.8	.02301	60.1	59.6	.04636	37.0	57.0	.00968	39.9
30	30.7	.02301	60.1	59.6	.04636	37.0	57.0	.00968	39.9
Aug. 9	30.7	.02301	60.1	59.6	.04636	37.0	57.0	.00968	39.8
19	30.7	.02301	60.0	59.6	.04636	37.0	57.0	.00968	39.8
29	30.7	.02301	60.0	59.6	.04636	36.9	57.0	.00968	39.8
Sep. 8	30.6	.02302	60.0	59.5	.04637	36.9	57.0	.00968	39.8
18	30.6	.02302	60.0	59.5	.04637	36.9	57.0	.00968	39.7
28	30.6	.02302	60.0	59.5	.04637	36.9	57.0	.00968	39.7
Oct. 8	30.6	.02302	60.0	59.5	.04637	36.9	57.0	.00968	39.7
17	30.5	.02302	60.0	59.5	.04637	36.9	57.0	.00968	39.6
27	30.5	.02302	60.0	59.4	.04638	36.9	57.0	.00968	39.6
Nov. 6	30.5	.02302	60.0	59.4	.04638	36.9	57.0	.00968	39.6
16	30.5	.02302	60.0	59.4	.04638	36.9	56.9	.00968	39.6
26	30.4	.02302	60.1	59.4	.04638	36.9	56.9	.00968	39.6
Dec. 6	30.4	.02302	60.1	59.4	.04638	37.0	56.9	.00968	39.6
16	30.4	.02302	60.2	59.4	.04638	37.0	56.9	.00968	39.6
26	30.4	.02302	60.2	59.4	.04638	37.0	56.9	.00968	39.7
1926 Jan. 5	30.4	.02302	60.3	59.4	.04638	37.1	56.8	.00968	39.7

TABLE VII—(*Continued*)

VALUES OF c, LOG COSEC c, AND RAN $+ n$ FOR 27 SELECTED STARS (1925)

	Gamma Draconis (Etamin)			Alpha Lyrae (Vega)			Alpha Aquilae (Altair)		
	c	log cosec c	RAN$+n$	c	log cosec c	RAN$+n$	c	log cosec c	RAN$+n$
	38°		87°	51°		97°	81°		116°
1925	′		′	′		′	′		′
Jan. 1	58.5	.20136	28.6	34.7	.10598	45.0	16.4	.00506	36.3
11	58.5	.20136	28.6	34.7	.10598	45.1	16.3	.00506	36.4
21	58.5	.20136	28.7	34.7	.10598	45.1	16.3	.00506	36.4
31	58.5	.20136	28.7	34.7	.10598	45.2	16.3	.00506	36.4
Feb. 10	58.5	.20136	28.7	34.7	.10598	45.2	16.3	.00506	36.5
20	58.5	.20136	28.8	34.7	.10598	45.2	16.2	.00506	36.5
Mar. 2	58.5	.20136	28.8	34.7	.10598	45.3	16.2	.00506	36.6
12	58.5	.20136	28.8	34.7	.10598	45.3	16.2	.00506	36.6
22	58.5	.20136	28.9	34.7	.10598	45.3	16.1	.00506	36.7
Apr. 1	58.5	.20136	28.9	34.7	.10598	45.4	16.1	.00506	36.7
11	58.5	.20136	28.9	34.7	.10598	45.4	16.1	.00506	36.8
21	58.5	.20136	29.0	34.7	.10598	45.5	16.1	.00506	36.9
May 1	58.5	.20136	29.0	34.7	.10598	45.5	16.1	.00506	36.9
11	58.5	.20136	29.0	34.7	.10598	45.5	16.1	.00506	37.0
21	58.5	.20136	29.1	34.7	.10598	45.6	16.1	.00506	37.0
31	58.5	.20136	29.1	34.7	.10598	45.6	16.1	.00506	37.1
June 10	58.5	.20136	29.1	34.7	.10598	45.7	16.1	.00506	37.2
20	58.5	.20136	29.2	34.7	.10598	45.7	16.1	.00506	37.2
30	58.5	.20136	29.2	34.7	.10598	45.7	16.1	.00506	37.3
July 10	58.5	.20136	29.2	34.7	.10598	45.7	16.1	.00506	37.3
20	58.5	.20136	29.2	34.7	.10598	45.8	16.2	.00506	37.3
30	58.5	.20136	29.2	34.7	.10598	45.8	16.2	.00506	37.3
Aug. 9	58.5	.20136	29.2	34.7	.10598	45.8	16.2	.00506	37.3
19	58.5	.20136	29.2	34.7	.10598	45.8	16.3	.00506	37.3
29	58.5	.20136	29.2	34.7	.10598	45.8	16.3	.00506	37.3
Sep. 8	58.5	.20136	29.2	34.7	.10598	45.8	16.3	.00506	37.3
18	58.5	.20136	29.2	34.7	.10598	45.7	16.3	.00506	37.3
28	58.5	.20136	29.2	34.7	.10598	45.7	16.4	.00506	37.2
Oct. 8	58.5	.20136	29.2	34.7	.10598	45.7	16.4	.00506	37.2
17	58.5	.20136	29.2	34.7	.10598	45.7	16.4	.00506	37.2
27	58.5	.20136	29.2	34.7	.10598	45.7	16.4	.00506	37.1
Nov. 6	58.5	.20136	29.2	34.7	.10598	45.7	16.4	.00506	37.1
16	58.5	.20136	29.2	34.7	.10598	45.7	16.4	.00506	37.1
26	58.5	.20136	29.2	34.7	.10598	45.7	16.4	.00506	37.1
Dec. 6	58.5	.20136	29.2	34.7	.10598	45.7	16.4	.00506	37.1
16	58.5	.20136	29.3	34.7	.10598	45.7	16.4	.00506	37.1
26	58.5	.20136	29.3	34.7	.10598	45.7	16.4	.00506	37.1
1926									
Jan. 5	58.5	.20136	29.3	34.7	.10598	45.8	16.3	.00506	37.1

TABLE VII—(*Continued*)

VALUES OF *c*, LOG COSEC *c*, AND RAN + *n* FOR 27 SELECTED STARS (1925)

	Alpha Cygni (Deneb)			Epsilon Pegasi (Enif)			Alpha Pegasi (Markab)		
	c	log cosec *c*	RAN+*n*	*c*	log cosec *c*	RAN+*n*	*c*	log cosec *c*	RAN+*n*
1925	**44°** ′		**128°** ′	**79°** ′		**144°** ′	**74°** ′		**165°** ′
Jan. 1	41.6	.15285	39.1	54.1	.00678	57.5	20.6	.01642	3.9
11	41.6	.15285	39.1	54.0	.00678	57.5	20.6	.01642	3.9
21	41.6	.15285	39.1	54.0	.00678	57.5	20.6	.01642	3.9
31	41.6	.15285	39.1	54.0	.00678	57.5	20.6	.01642	3.9
Feb. 10	41.6	.15285	39.2	53.9	.00678	57.5	20.5	.01642	3.9
20	41.6	.15285	39.2	53.9	.00678	57.5	20.5	.01642	3.9
Mar. 2	41.6	.15285	39.2	53.9	.00678	57.5	20.5	.01642	3.9
12	41.6	.15285	39.2	53.8	.00679	57.5	20.4	.01643	3.9
22	41.6	.15285	39.3	53.8	.00679	57.6	20.4	.01643	4.0
Apr. 1	41.6	.15285	39.3	53.8	.00679	57.6	20.4	.01643	4.0
11	41.6	.15285	39.3	53.7	.00679	57.7	20.3	.01643	4.0
21	41.6	.15285	39.4	53.7	.00679	57.7	20.3	.01643	4.1
May 1	41.5	.15286	39.4	53.7	.00679	57.8	20.2	.01643	4.1
11	41.5	.15286	39.5	53.6	.00679	57.9	20.2	.01643	4.2
21	41.5	.15286	39.5	53.6	.00679	57.9	20.2	.01643	4.2
31	41.5	.15286	39.5	53.6	.00679	58.0	20.1	.01644	4.3
June 10	41.5	.15286	39.6	53.6	.00679	58.1	20.1	.01644	4.4
20	41.5	.15286	39.6	53.6	.00679	58.1	20.1	.01644	4.4
30	41.5	.15286	39.7	53.5	.00680	58.2	20.1	.01644	4.5
July 10	41.5	.15286	39.7	53.5	.00680	58.2	20.1	.01644	4.5
20	41.5	.15286	39.7	53.5	.00680	58.3	20.1	.01644	4.6
30	41.5	.15286	39.8	53.6	.00679	58.3	20.1	.01644	4.6
Aug. 9	41.5	.15286	39.8	53.6	.00679	58.3	20.1	.01644	4.7
19	41.5	.15286	39.8	53.6	.00679	58.4	20.1	.01644	4.7
29	41.5	.15286	39.8	53.6	.00679	58.4	20.2	.01643	4.7
Sep. 8	41.5	.15286	39.8	53.7	.00679	58.4	20.2	.01643	4.8
18	41.5	.15286	39.8	53.7	.00679	58.4	20.2	.01643	4.8
28	41.6	.15285	39.8	53.8	.00679	58.4	20.3	.01643	4.8
Oct. 8	41.6	.15285	39.8	53.8	.00679	58.3	20.3	.01643	4.8
17	41.6	.15285	39.8	53.9	.00678	58.3	20.4	.01643	4.8
27	41.6	.15285	39.8	53.9	.00678	58.3	20.4	.01643	4.8
Nov. 6	41.6	.15285	39.8	54.0	.00678	58.3	20.5	.01642	4.7
16	41.6	.15285	39.8	54.0	.00678	58.2	20.5	.01642	4.7
26	41.6	.15285	39.8	54.0	.00678	58.2	20.5	.01642	4.7
Dec. 6	41.6	.15285	39.8	54.0	.00678	58.2	20.5	.01642	4.7
16	41.6	.15285	39.8	54.0	.00678	58.2	20.6	.01642	4.7
26	41.6	.15285	39.8	54.0	.00678	58.2	20.6	.01642	4.7
1926 Jan. 5	41.6	.15285	39.8	54.0	.00678	58.2	20.6	.01642	4.6

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North Star Navigation

Supplement for 1926

BY
L. M. BERKELEY

Supplement - to be bound between pages 84 and the index.

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84 B.

North Star Navigation

Supplement for 1926

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63.

PUBLISHERS' NOTE

The following pages contain (for 1926) those tables in which alterations are made necessary by the changing coördinates of the stars. These tables are III, VI, and VII. The other tables remain as in the original work.

The paging of the original work is preserved, so that the index therein given suffices for this new matter (which merely replaces the corresponding pages of old matter).

Should the reader be inclined to think that the price asked for this supplement is too high, he is respectfully asked to look at Table VII, and to make an estimate of the number of spherical triangles that had to be solved in calculating it.

TABLE III

Latitude Correction (a_2)

	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	180	179	178	177	176	175	174	173	172	171	170	169	168	167	166
	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194
	360	359	358	357	356	355	354	353	352	351	350	349	348	347	346
$a + a_1$	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
10	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
13	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
14	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
15	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
18	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
19	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
20	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
23	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
24	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
25	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
28	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
29	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
30	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
31	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
33	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
34	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
35	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
36	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
38	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
39	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
40	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
41	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
42	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
43	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
44	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
45	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
46	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
48	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
49	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
50	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
51	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
52	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
53	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
54	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1
55	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1
56	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
57	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1
58	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1
59	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1
60	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1
61	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
62	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1
63	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1
64	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1
65	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1
66	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1
67	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1
68	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1
69	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1
70	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1

TABLE III—(*Continued*)

LATITUDE CORRECTION (a_2)

	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
	165	164	163	162	161	160	159	158	157	156	155	154	153	152	151
	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209
	345	344	343	342	341	340	339	338	337	336	335	334	333	332	331
$a + a_1$	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
10	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
13	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
14	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
15	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
18	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
19	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1
20	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
22	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1
23	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1
24	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1
25	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1
26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1
27	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1
28	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1
29	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1
30	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	,1	.1
31	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
32	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1
33	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1
34	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1
35	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
36	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
37	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
38	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
39	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
40	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
41	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
42	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
43	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
44	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	,1
45	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
46	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
47	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2
48	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2
49	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2
50	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2
51	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2
52	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2
53	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2
54	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2
55	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2
56	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2
57	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2
58	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2
59	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2
60	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2	.3
61	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3
62	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2	.3	.3
63	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.3	.3	.3
64	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2	.3	.3	.3
65	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.3	.3	.3	.3
66	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3
67	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3
68	.1	.1	.1	.1	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3	.4
69	.1	.1	.1	.2	.2	.2	.2	.2	.2	.3	.3	.3	.3	.4	.4
70	.1	.1	.2	.2	.2	.2	.2	.2	.3	.3	.3	.3	.4	.4	.4

TABLE III—(*Continued*)

LATITUDE CORRECTION (a_2)

	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
	150	149	148	147	146	145	144	143	142	141	140	139	138	137	136
	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224
	330	329	328	327	326	325	324	323	322	321	320	319	318	317	316
$a + a_1$	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
10	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
12	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1
13	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1
14	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
15	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
16	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
17	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
18	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
19	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
20	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
21	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
22	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
23	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
24	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
25	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
26	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
27	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2
28	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2
29	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2
30	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2
31	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2
32	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2
33	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2
34	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2	.2
35	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2
36	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
37	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
38	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
39	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
40	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.3
41	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3
42	.1	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.3	.3	.3
43	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.3	.3	.3	.3
44	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.3	.3	.3	.3
45	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3
46	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3
47	.2	.2	.2	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3	.3
48	.2	.2	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3	.3	.3
49	.2	.2	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3	.3	.3
50	.2	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3	.3	.3	.4
51	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4
52	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3	.3	.3	.4	.4	.4
53	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3	.3	.4	.4	.4	.4
54	.2	.2	.2	.3	.3	.3	.3	.3	.3	.3	.4	.4	.4	.4	.4
55	.2	.2	.3	.3	.3	.3	.3	.3	.3	.4	.4	.4	.4	.4	.4
56	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4
57	.2	.3	.3	.3	.3	.3	.3	.3	.4	.4	.4	.4	.4	.4	.5
58	.3	.3	.3	.3	.3	.3	.3	.4	.4	.4	.4	.4	.4	.5	.5
59	.3	.3	.3	.3	.3	.3	.4	.4	.4	.4	.4	.4	.5	.5	.5
60	.3	.3	.3	.3	.3	.4	.4	.4	.4	.4	.4	.5	.5	.5	.5
61	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5
62	.3	.3	.3	.3	.4	.4	.4	.4	.4	.5	.5	.5	.5	.5	.6
63	.3	.3	.3	.4	.4	.4	.4	.4	.5	.5	.5	.5	.6	.6	.6
64	.3	.3	.4	.4	.4	.4	.4	.5	.5	.5	.5	.6	.6	.6	.6
65	.3	.4	.4	.4	.4	.4	.5	.5	.5	.5	.6	.6	.6	.6	.6
66	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7
67	.4	.4	.4	.4	.5	.5	.5	.5	.6	.6	.6	.6	.7	.7	.7
68	.4	.4	.4	.5	.5	.5	.5	.6	.6	.6	.6	.7	.7	.7	.7
69	.4	.4	.5	.5	.5	.5	.6	.6	.6	.6	.7	.7	.7	.8	.8
70	.4	.5	.5	.5	.5	.6	.6	.6	.6	.7	.7	.7	.8	.8	.8

TABLE III—(*Continued*)

LATITUDE CORRECTION (a_2)

$a + a_1$ °	p ° 45 135 225 315 a_2 ′	p ° 46 134 226 314 a_2 ′	p ° 47 133 227 313 a_2 ′	p ° 48 132 228 312 a_2 ′	p ° 49 131 229 311 a_2 ′	p ° 50 130 230 310 a_2 ′	p ° 51 129 231 309 a_2 ′	p ° 52 128 232 308 a_2 ′	p ° 53 127 233 307 a_2 ′	p ° 54 126 234 306 a_2 ′	p ° 55 125 235 305 a_2 ′	p ° 56 124 236 304 a_2 ′	p ° 57 123 237 303 a_2 ′	p ° 58 122 238 302 a_2 ′	p ° 59 121 239 301 a_2 ′
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1
8	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
9	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
10	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
11	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
12	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
13	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
14	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
15	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
16	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
17	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
18	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
19	.1	.1	.1	.1	,1	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2
20	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2
21	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2
22	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2
23	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
24	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
25	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
26	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	.02
27	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
28	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
29	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.3
30	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.3	.3	.3
31	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3
32	.2	.2	.2	.2	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3
33	.2	.2	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3	.3	.3
34	.2	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3	.3	.3	.3
35	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
36	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
37	.2	.2	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
38	.2	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.4	.4
39	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.4	.4	.4
40	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.4	.4	.4	.4	.4
41	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4
42	.3	.3	.3	.3	.3	.3	.3	.3	.4	.4	.4	.4	.4	.4	.4
43	.3	.3	.3	.3	.3	.3	.4	.4	.4	.4	.4	.4	.4	.4	.4
44	.3	.3	.3	.3	.3	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4
45	.3	.3	.3	.3	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.5
46	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5
47	.3	.3	.4	.4	.4	.4	.4	.4	.4	.4	.4	.5	.5	.5	.5
48	.3	.4	.4	.4	.4	.4	.4	.4	.4	.5	.5	.5	.5	.5	.5
49	.4	.4	.4	.4	.4	.4	.4	.4	.5	.5	.5	.5	.5	.5	.5
50	.4	.4	.4	.4	.4	.4	.5	.5	.5	.5	.5	.5	.5	.5	.5
51	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.6
52	.4	.4	.4	.4	.5	.5	.5	.5	.5	.5	.5	.5	.6	.6	.6
53	.4	.4	.4	.5	.5	.5	.5	.5	.5	.5	.6	.6	.6	.6	.6
54	.4	.4	.5	.5	.5	.5	.5	.5	.5	.6	.6	.6	.6	.6	.7
55	.4	.5	.5	.5	.5	.5	.5	.6	.6	.6	.6	.6	.6	.6	.7
56	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7
57	.5	.5	.5	.5	.5	.6	.6	.6	.6	.6	.6	.7	.7	.7	.7
58	.5	.5	.5	.6	.6	.6	.6	.6	.6	.7	.7	.7	.7	.7	.7
59	.5	.5	.6	.6	.6	.6	.6	.6	.7	.7	.7	.7	.7	.7	.8
60	.5	.6	.6	.6	.6	.6	.7	.7	.7	.7	.7	.7	.8	.8	.8
61	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8
62	.6	.6	.6	.6	.7	.7	.7	.7	.7	.8	.8	.8	.8	.8	.9
63	.6	.6	.7	.7	.7	.7	.7	.8	.8	.8	.8	.8	.9	.9	.9
64	.6	.7	.7	.7	.7	.8	.8	.8	.8	.8	.9	.9	.9	.9	.9
65	.7	.7	.7	.7	.8	.8	.8	.8	.9	.9	.9	.9	.9	1.0	1.0
66	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0
67	.7	.8	.8	.8	.8	.9	.9	.9	.9	1.0	1.0	.0	.0	.1	.1
68	.8	.8	.8	.9	.9	.9	.9	1.0	1.0	.0	.0	.1	.1	.1	.1
69	.8	.8	.9	.9	.9	1.0	1.0	.0	.0	.1	.1	.1	.1	.2	.2
70	.9	.9	.9	.9	1.0	.0	.0	.1	.1	.1	.2	.2	.2	.2	.3

TABLE III—(*Continued*)

LATITUDE CORRECTION (a_2)

	p ° 60 120 240 300	p ° 61 119 241 299	p ° 62 118 242 298	p ° 63 117 243 297	p ° 64 116 244 296	p ° 65 115 245 295	p ° 66 114 246 294	p ° 67 113 247 293	p ° 68 112 248 292	p ° 69 111 249 291	p ° 70 110 250 290	p ° 71 109 251 289	p ° 72 108 252 288	p ° 73 107 253 287	p ° 74 106 254 286
$a + a_1$	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1
6	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
7	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
8	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
9	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
10	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
11	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
12	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
13	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
14	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
15	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2
16	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
17	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
18	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
19	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
20	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
21	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
22	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
23	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
24	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.3	.3	.3
25	.2	.2	.2	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3	.3
26	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
27	.2	.2	.2	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
28	.2	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
29	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
30	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
31	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
32	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.4	.4	.4
33	.3	.3	.3	.3	.3	.3	.3	.3	.3	.4	.4	.4	.4	.4	.4
34	.3	.3	.3	.3	.3	.3	.4	.4	.4	.4	.4	.4	.4	.4	.4
35	.3	.3	.3	.3	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4
36	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
37	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4
38	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.5
39	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.5	.5	.5	.5
40	.4	.4	.4	.4	.4	.4	.4	.4	.5	.5	.5	.5	.5	.5	.5
41	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
42	.4	.4	.4	.4	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5
43	.4	.4	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5
44	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.6	.6
45	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.6	.6	.6	.6	.6
46	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6
47	.5	.5	.5	.5	.5	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6
48	.5	.5	.5	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6
49	.5	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.7	.7	.7
50	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.7	.7	.7	.7	.7
51	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
52	.6	.6	.6	.6	.6	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7
53	.6	.6	.6	.7	.7	.7	.7	.7	.7	.7	.7	.7	.8	.8	.8
54	.6	.7	.7	.7	.7	.7	.7	.7	.7	.7	.8	.8	.8	.8	.8
55	.7	.7	.7	.7	.7	.7	.7	.8	.8	.8	.8	.8	.8	.8	.8
56	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9
57	.7	.7	.8	.8	.8	.8	.8	.8	.8	.8	.8	.9	.9	.9	.9
58	.8	.8	.8	.8	.8	.8	.8	.8	.9	.9	.9	.9	.9	.9	.9
59	.8	.8	.8	.8	.8	.9	.9	.9	.9	.9	.9	.9	.9	1.0	1.0
60	.8	.8	.8	.9	.9	.9	.9	.9	.9	.9	1.0	1.0	1.0	.0	.0
61	0.8	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
62	.9	.9	.9	.9	.9	1.0	1.0	.0	.0	.0	.0	.1	.1	.1	.1
63	.9	.9	1.0	1.0	1.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1
64	1.0	1.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2
65	.0	.0	.0	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2
66	1.1	1.1	1.1	1.1	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.3	1.3	1.3	1.3
67	.1	.1	.1	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3	.4
68	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3	.4	.4	.4	.4	.4
69	.2	.2	.3	.3	.3	.3	.4	.4	.4	.4	.4	.5	.5	.5	.5
70	.3	.3	.3	.4	.4	.4	.4	.5	.5	.5	.5	.5	.6	.6	.6

TABLE III—(*Continued*)

LATITUDE CORRECTION (a_2)

	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
	105	104	103	102	101	100	99	98	97	96	95	94	93	92	91	90
	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270
	285	284	283	282	281	280	279	278	277	276	275	274	273	272	271	270
$a + a_1$	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2	a_2
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
5	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
6	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
7	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
8	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
9	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
10	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
11	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
12	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
13	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
14	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
15	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
16	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
17	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
18	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
19	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
20	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
21	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
22	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3
23	.2	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
24	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
25	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
26	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
27	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
28	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
29	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
30	.3	.3	.3	.3	.3	.3	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4
31	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
32	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4
33	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4
34	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4
35	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4
36	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5
37	.4	.4	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5
38	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5
39	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5
40	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5
41	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
42	.5	.5	.5	.5	.5	.5	.5	.6	.6	.6	.6	.6	.6	.6	.6	.6
43	.5	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6
44	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6
45	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6
46	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
47	.6	.6	.6	.6	.6	.6	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7
48	.6	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7
49	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7
50	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7
51	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
52	.7	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8
53	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8
54	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.9	.9	.9	.9	.9	.9
55	.8	.8	.8	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9
56	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
57	.9	.9	.9	.9	.9	.9	.9	.9	.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0
58	.9	.9	.9	1.0	1.0	1.0	1.0	1.0	1.0	.0	.0	.0	.0	.0	.0	.0
59	1.0	1.0	1.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
60	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
61	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
62	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2
63	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
64	.2	.2	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3	.3	.3	.3
65	.2	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
66	1.3	1.3	1.3	1.3	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
67	.4	.4	.4	.4	.4	.4	.4	.4	.4	.5	.5	.5	.5	.5	.5	.5
68	.4	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5
69	.5	.5	.5	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6
70	.6	.6	.6	.6	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7

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TABLE VI

RAN, LOG COS d, AND SID. TIME OF 0^h G. C. T. FOR EACH DAY IN THE YEAR 1926

1926	RAN	log cos d	Sid. Time of 0^h G. C. T.			1926	RAN	log cos d	Sid. Time of 0^h G. C. T.		
	23° ′		h	m	s		23° ′		h	m	s
Jan. 1	46.9	8.2786	6	39	32.9	Mar. 1	30.8	8.2789	10	32	9.7
2	46.6	8.2786	6	43	29.4	2	30.6	8.2790	10	36	6.2
3	46.3	8.2786	6	47	26.0	3	30.4	8.2790	10	40	2.8
4	46.0	8.2786	6	51	22.6	4	30.2	8.2790	10	43	59.3
5	45.7	8.2786	6	55	19.1	5	30.1	8.2791	10	47	55.9
6	45.4	8.2786	6	59	15.7	6	29.9	8.2791	10	51	52.4
7	45.1	8.2785	7	3	12.2	7	29.8	8.2791	10	55	49.0
8	44.8	8.2785	7	7	8.8	8	29.6	8.2791	10	59	45.5
9	44.6	8.2785	7	11	5.4	9	29.4	8.2792	11	3	42.1
10	44.3	8.2785	7	15	1.9	10	29.3	8.2792	11	7	38.6
11	44.1	8.2785	7	18	58.5	11	29.1	8.2792	11	11	35.2
12	43.8	8.2785	7	22	55.0	12	28.9	8.2792	11	15	31.8
13	43.5	8.2785	7	26	51.6	13	28.7	8.2793	11	19	28.3
14	43.2	8.2785	7	30	48.1	14	28.5	8.2793	11	23	24.9
15	42.9	8.2785	7	34	44.7	15	28.3	8.2793	11	27	21.4
16	42.6	8.2785	7	38	41.3	16	28.2	8.2794	11	31	18.0
17	42.3	8.2785	7	42	37.8	17	28.1	8.2794	11	35	14.5
18	42.0	8.2785	7	46	34.4	18	28.0	8.2794	11	39	11.1
19	41.6	8.2785	7	50	30.9	19	27.9	8.2795	11	43	7.6
20	41.4	8.2785	7	54	27.5	20	27.8	8.2795	11	47	4.2
21	41.1	8.2785	7	58	24.0	21	27.7	8.2795	11	51	0.7
22	40.8	8.2785	8	2	20.6	22	27.6	8.2796	11	54	57.3
23	40.6	8.2785	8	6	17.2	23	27.5	8.2796	11	58	53.8
24	40.3	8.2785	8	10	13.7	24	27.4	8.2796	12	2	50.4
25	40.0	8.2785	8	14	10.3	25	27.2	8.2796	12	6	46.9
26	39.8	8.2785	8	18	6.8	26	27.1	8.2797	12	10	43.5
27	39.5	8.2785	8	22	3.4	27	27.0	8.2797	12	14	40.0
28	39.2	8.2785	8	25	59.9	28	26.9	8.2797	12	18	36.6
29	38.8	8.2785	8	29	56.5	29	26.8	8.2798	12	22	33.1
30	38.5	8.2785	8	33	53.0	30	26.7	8.2798	12	26	29.7
31	38.2	8.2785	8	37	49.6	31	26.7	8.2799	12	30	26.2
Feb. 1	37.9	8.2785	8	41	46.2	Apr. 1	26.6	8.2799	12	34	22.8
2	37.6	8.2785	8	45	42.7	2	26.6	8.2799	12	38	19.4
3	37.3	8.2785	8	49	39.3	3	26.6	8.2800	12	42	15.9
4	37.0	8.2785	8	53	35.8	4	26.6	8.2800	12	46	12.5
5	36.8	8.2785	8	57	32.4	5	26.6	8.2800	12	50	9.0
6	36.5	8.2785	9	1	28.9	6	26.5	8.2801	12	54	5.6
7	36.3	8.2786	9	5	25.5	7	26.5	8.2801	12	58	2.1
8	36.1	8.2786	9	9	22.0	8	26.4	8.2801	13	1	58.7
9	35.8	8.2786	9	13	18.6	9	26.4	8.2802	13	5	55.2
10	35.5	8.2786	9	17	15.2	10	26.3	8.2802	13	9	51.8
11	35.3	8.2786	9	21	11.7	11	26.3	8.2802	13	13	48.3
12	35.0	8.2786	9	25	8.3	12	26.3	8.2803	13	17	44.9
13	34.7	8.2786	9	29	4.8	13	26.3	8.2803	13	21	41.4
14	34.4	8.2786	9	33	1.4	14	26.4	8.2803	13	25	38.0
15	34.1	8.2787	9	36	57.9	15	26.4	8.2804	13	29	34.5
16	33.8	8.2787	9	40	54.5	16	26.5	8.2804	13	33	31.1
17	33.6	8.2787	9	44	51.0	17	26.5	8.2804	13	37	27.6
18	33.4	8.2787	9	48	47.6	18	26.6	8.2805	13	41	24.2
19	33.2	8.2787	9	52	44.1	19	26.6	8.2805	13	45	20.8
20	33.0	8.2788	9	56	40.7	20	26.6	8.2805	13	49	17.3
21	32.7	8.2788	10	0	37.2	21	26.7	8.2806	13	53	13.9
22	32.5	8.2788	10	4	33.8	22	26.7	8.2806	13	57	10.4
23	32.3	8.2788	10	8	30.4	23	26.7	8.2806	14	1	7.0
24	32.0	8.2788	10	12	26.9	24	26.7	8.2807	14	5	3.5
25	31.8	8.2788	10	16	23.5	25	26.8	8.2807	14	9	0.1
26	31.6	8.2789	10	20	20.0	26	26.9	8.2807	14	12	56.6
27	31.3	8.2789	10	24	16.6	27	26.9	8.2808	14	16	53.2
28	31.1	8.2789	10	28	13.1	28	27.0	8.2808	14	20	49.7
						29	27.2	8.2808	14	24	46.3
						30	27.3	8.2809	14	28	42.8

TABLE VI—(*Continued*)

RAN, LOG COS *d*, AND SID. TIME OF 0^h G. C. T. FOR EACH DAY IN THE YEAR 1926

1926	RAN	log cos *d*	Sid. Time of 0^h G. C. T.			1926	RAN	log cos *d*	Sid. Time of 0^h G. C. T.		
	23° ′		h	m	s		23° ′		h	m	s
May 1	27.4	8.2809	14	32	39.4	July 1	40.2	8.2819	18	33	9.4
2	27.6	8.2809	14	36	36.0	2	40.4	8.2819	18	57	5.9
3	27.7	8.2809	14	40	32.5	3	40.7	8.2819	18	41	2.5
4	27.8	8.2810	14	44	29.1	4	41.0	8.2819	18	44	59.0
5	27.9	8.2810	14	48	25.6	5	41.3	8.2820	18	48	55.6
6	27.9	8.2810	14	52	22.2	6	41.6	8.2819	18	52	52.1
7	28.0	8.2811	14	56	18.7	7	41.9	8.2819	18	56	48.7
8	28.1	8.2811	15	0	15.3	8	42.3	8.2819	19	0	45.2
9	28.3	8.2811	15	4	11.8	9	42.6	8.2819	19	4	41.8
10	28.4	8.2812	15	8	8.4	10	42.8	8.2819	19	8	38.4
11	28.6	8.2812	15	12	5.0	11	43.1	8.2819	19	12	34.9
12	28.8	8.2812	15	16	1.5	12	43.4	8.2819	19	16	31.5
13	28.9	8.2812	15	19	58.1	13	43.6	8.2819	19	20	28.0
14	29.1	8.2813	15	23	54.6	14	43.9	8.2819	19	24	24.6
15	29.3	8.2813	15	27	51.2	15	44.1	8.2819	19	28	21.2
16	29.5	8.2813	15	31	47.7	16	44.4	8.2819	19	32	17.7
17	29.6	8.2813	15	35	44.3	17	44.7	8.2819	19	36	14.3
18	29.8	8.2814	15	39	40.8	18	44.9	8.2819	19	40	10.8
19	29.9	8.2814	15	43	37.4	19	45.2	8.2819	19	44	7.4
20	30.1	8.2814	15	47	34.0	20	45.6	8.2819	19	48	3.9
21	30.2	8.2814	15	51	30.5	21	45.9	8.2819	19	52	0.5
22	30.4	8.2815	15	55	27.1	22	46.2	8.2818	19	55	57.0
23	30.6	8.2815	15	59	23.6	23	46.5	8.2818	19	59	53.6
24	30.8	8.2815	16	3	20.2	24	46.8	8.2818	20	3	50.2
25	31.0	8.2815	16	7	16.7	25	47.1	8.2818	20	7	46.7
26	31.2	8.2816	16	11	13.3	26	47.3	8.2818	20	11	43.3
27	31.5	8.2816	16	15	9.8	27	47.6	8.2818	20	15	39.8
28	31.7	8.2816	16	19	6.4	28	47.8	8.2817	20	19	36.4
29	31.9	8.2816	16	23	3.0	29	48.0	8.2817	20	23	32.9
30	32.2	8.2816	16	26	59.5	30	48.3	8.2817	20	27	29.5
31	32.4	8.2816	16	30	56.1	31	48.6	8.2817	20	31	26.0
June 1	32.6	8.2817	16	34	52.6	Aug. 1	48.9	8.2817	20	35	22.6
2	32.8	8.2817	16	38	49.2	2	49.2	8.2817	20	39	19.2
3	33.0	8.2817	16	42	45.8	3	49.5	8.2817	20	43	15.7
4	33.2	8.2817	16	46	42.3	4	49.8	8.2816	20	47	12.3
5	33.4	8.2817	16	50	38.9	5	50.1	8.2816	20	51	8.8
6	33.6	8.2817	16	54	35.4	6	50.3	8.2816	20	55	5.4
7	33.9	8.2818	16	58	32.0	7	50.6	8.2816	20	59	1.9
8	34.1	8.2818	17	2	28.5	8	50.8	8.2815	21	2	58.5
9	34.4	8.2818	17	6	25.1	9	51.1	8.2815	21	6	55.0
10	34.7	8.2818	17	10	21.6	10	51.3	8.2815	21	10	51.6
11	35.0	8.2818	17	14	18.2	11	51.5	8.2815	21	14	48.2
12	35.2	8.2818	17	18	14.8	12	51.8	8.2815	21	18	44.7
13	35.5	8.2818	17	22	11.3	13	52.0	8.2814	21	22	41.3
14	35.7	8.2818	17	26	7.9	14	52.2	8.2814	21	26	37.8
15	35.9	8.2819	17	30	4.4	15	52.5	8.2814	21	30	34.4
16	36.2	8.2819	17	34	1.0	16	52.8	8.2814	21	34	30.9
17	36.4	8.2819	17	37	57.6	17	53.0	8.2814	21	38	27.5
18	36.6	8.2819	17	41	54.1	18	53.3	8.2813	21	42	24.0
19	36.9	8.2819	17	45	50.7	19	53.6	8.2813	21	46	20.6
20	37.1	8.2819	17	49	47.2	20	53.9	8.2813	21	50	17.2
21	37.4	8.2819	17	53	43.8	21	54.1	8.2812	21	54	13.7
22	37.7	8.2819	17	57	40.3	22	54.3	8.2812	21	58	10.3
23	38.0	8.2819	18	1	36.9	23	54.5	8.2812	22	2	6.8
24	38.3	8.2819	18	5	33.4	24	54.7	8.2811	22	6	3.4
25	38.6	8.2819	18	9	30.0	25	54.9	8.2811	22	9	59.9
26	38.9	8.2819	18	13	26.6	26	55.1	8.2811	22	13	56.5
27	39.2	8.2819	18	17	23.1	27	55.3	8.2811	22	17	53.0
28	39.5	8.2819	18	21	19.7	28	55.6	8.2810	22	21	49.6
29	39.7	8.2819	18	25	16.2	29	55.8	8.2810	22	25	46.1
30	39.9	8.2819	18	29	12.8	30	56.1	8.2810	22	29	42.7
						31	56.3	8.2809	22	33	39.2

TABLE VI—(*Continued*)

RAN, LOG COS *d*, AND SID. TIME OF 0^h G. C. T. FOR EACH DAY IN THE YEAR 1926

1926	RAN	log cos *d*	Sid. Time of 0^h G. C. T.			1926	RAN	log cos *d*	Sid. Time of 0^h G. C. T.		
	23°						23°				
	′		h	m	s		′		h	m	s
Sept. 1	56.5	8.2809	22	37	35.8	Nov. 1	62.3	8.2784	2	38	5.5
2	56.8	8.2809	22	41	32.4	2	62.2	8.2784	2	42	2.1
3	57.0	8.2808	22	45	28.9	3	62.2	8.2784	2	45	58.6
4	57.1	8.2808	22	49	25.4	4	62.2	8.2783	2	49	55.2
5	57.3	8.2808	22	53	22.0	5	62.1	8.2783	2	53	51.8
6	57.5	8.2807	22	57	18.6	6	62.1	8.2783	2	57	48.3
7	57.6	8.2807	23	1	15.1	7	62.1	8.2782	3	1	44.9
8	57.8	8.2807	23	5	11.7	8	62.0	8.2782	3	5	41.4
9	58.0	8.2806	23	9	8.2	9	62.0	8.2781	3	9	38.0
10	58.1	8.2806	23	13	4.8	10	61.9	8.2781	3	13	34.5
11	58.3	8.2806	23	17	1.3	11	61.8	8.2780	3	17	31.1
12	58.5	8.2805	23	20	57.9	12	61.7	8.2780	3	21	27.6
13	58.7	8.2805	23	24	54.4	13	61.6	8.2780	3	25	24.2
14	58.9	8.2805	23	28	51.0	14	61.4	8.2779	3	29	20.8
15	59.1	8.2804	23	32	47.5	15	61.3	8.2779	3	33	17.3
16	59.3	8.2804	23	36	44.1	16	61.2	8.2778	3	37	13.9
17	59.5	8.2804	23	40	40.6	17	61.1	8.2778	3	41	10.4
18	59.6	8.2803	23	44	37.2	18	61.0	8.2778	3	45	7.0
19	59.7	8.2803	23	48	33.8	19	61.0	8.2777	3	49	3.5
20	59.8	8.2802	23	52	30.3	20	60.9	8.2777	3	53	0.1
21	60.0	8.2802	23	56	26.8	21	60.8	8.2777	3	56	56.6
22	60.1	8.2802	0	0	23.4	22	60.7	8.2776	4	0	53.2
23	60.2	8.2801	0	4	20.0	23	60.5	8.2776	4	4	49.8
24	60.3	8.2801	0	8	16.5	24	60.4	8.2775	4	8	46.3
25	60.5	8.2800	0	12	13.1	25	60.2	8.2775	4	12	42.9
26	60.6	8.2800	0	16	9.6	26	60.0	8.2775	4	16	39.4
27	60.8	8.2800	0	20	6.2	27	59.8	8.2774	4	20	36.0
28	61.0	8.2799	0	24	2.7	28	59.7	8.2774	4	24	32.5
29	61.1	8.2799	0	27	59.3	29	59.5	8.2774	4	28	29.1
30	61.2	8.2798	0	31	55.8	30	59.3	8.2773	4	32	25.6
Oct. 1	61.3	8.2798	0	35	52.4	Dec. 1	59.1	8.2773	4	36	22.2
2	61.4	8.2798	0	39	48.9	2	59.0	8.2773	4	40	18.8
3	61.4	8.2797	0	43	45.5	3	58.8	8.2772	4	44	15.3
4	61.5	8.2797	0	47	42.0	4	58.7	8.2772	4	48	11.9
5	61.6	8.2796	0	51	38.6	5	58.5	8.2772	4	52	8.4
6	61.6	8.2796	0	55	35.1	6	58.4	8.2771	4	56	5.0
7	61.7	8.2796	0	59	31.7	7	58.2	8.2771	5	0	1.6
8	61.8	8.2795	1	3	28.2	8	58.0	8.2771	5	3	58.1
9	61.9	8.2795	1	7	24.8	9	57.8	8.2770	5	7	54.7
10	62.0	8.2794	1	11	21.4	10	57.5	8.2770	5	11	51.2
11	62.1	8.2794	1	15	17.9	11	57.3	8.2770	5	15	47.8
12	62.1	8.2794	1	19	14.5	12	57.0	8.2769	5	19	44.4
13	62.2	8.2793	1	23	11.0	13	56.8	8.2769	5	23	40.9
14	62.3	8.2793	1	27	7.6	14	56.6	8.2769	5	27	37.5
15	62.3	8.2792	1	31	4.1	15	56.4	8.2769	5	31	34.0
16	62.4	8.2792	1	35	0.7	16	56.2	8.2769	5	35	30.6
17	62.4	8.2791	1	38	57.2	17	56.0	8.2768	5	39	27.1
18	62.4	8.2790	1	42	53.8	18	55.8	8.2768	5	43	23.7
19	62.4	8.2790	1	46	50.3	19	55.6	8.2768	5	47	20.2
20	62.4	8.2790	1	50	46.9	20	55.4	8.2767	5	51	16.8
21	62.4	8.2789	1	54	43.4	21	55.1	8.2767	5	55	13.4
22	62.5	8.2789	1	58	40.0	22	54.8	8.2767	5	59	9.9
23	62.5	8.2788	2	2	36.5	23	54.6	8.2767	6	3	6.5
24	62.6	8.2788	2	6	33.1	24	54.3	8.2767	6	7	3.0
25	62.6	8.2788	2	10	29.6	25	54.0	8.2766	6	10	59.6
26	62.6	8.2787	2	14	26.2	26	53.7	8.2766	6	14	56.2
27	62.6	8.2787	2	18	22.8	27	53.4	8.2766	6	18	52.7
28	62.5	8.2786	2	22	19.3	28	53.2	8.2766	6	22	49.3
29	62.5	8.2786	2	26	15.9	29	52.9	8.2766	6	26	45.8
30	62.4	8.2785	2	30	12.4	30	52.7	8.2766	6	30	42.4
31	62.4	8.2785	2	34	9.0	31	52.4	8.2765	6	34	39.0

TABLE VII

Values of c, log cosec c, and RAN + n for 27 Selected Stars (1926), as Follows:

Name	Magnitude	R. A.		Dec.		Page
		h	m	°	′	
Alpha Andromedae (Alpheratz)	2.2	0	5	28	41	75
Beta Cassiopeiae (Caph)	2.4	0	5	58	44	75
Beta Ceti (Daneb Kaitos)	2.2	0	40	−18	24	75
Alpha Arietis (Hamal)	2.2	2	3	23	7	76
Alpha Persei (Mirfak)	1.9	3	19	49	36	76
Alpha Tauri (Aldebaran)	1.1	4	32	16	22	76
Beta Orionis (Rigel)	0.3	5	11	− 8	17	77
Alpha Aurigae (Capella)	0.2	5	11	45	55	77
Alpha Orionis (Betelgeux)	1.0	5	51	7	24	77
Alpha Canis Majoris (Sirius)	−1.6	6	42	−16	37	78
Alpha Canis Minoris (Procyon)	0.5	7	35	5	27	78
Beta Geminorum (Pollux)	1.2	7	41	28	13	78
Alpha Hydrae (Alphard)	2.2	9	24	− 8	20	79
Alpha Leonis (Regulus)	1.3	10	4	12	20	79
Alpha Ursae Majoris (Dubhe)	2.0	10	59	62	9	79
Beta Leonis (Denebola)	2.2	11	45	14	59	80
Alpha Virginis (Spica)	1.2	13	21	−10	46	80
Eta Ursae Majoris (Alkaid)	1.9	13	45	49	41	80
Alpha Boötis (Arcturus)	0.2	14	12	19	34	81
Alpha Coronae Borealis (Alphecca)	2.3	15	32	26	58	81
Alpha Ophiuchi (Rasalhague)	2.1	17	31	12	37	81
Gamma Draconis (Etamin)	2.4	17	55	51	30	82
Alpha Lyrae (Vega)	0.1	18	34	38	43	82
Alpha Aquilae (Altair)	0.9	19	47	8	40	82
Alpha Cygni (Deneb)	1.3	20	39	45	1	83
Epsilon Pegasi (Enif)	2.5	21	41	9	32	83
Alpha Pegasi (Markab)	2.6	23	1	14	48	83

TABLE VII—(*Continued*)

VALUES OF *c*, LOG COSEC *c*, AND RAN + *n* FOR 27 SELECTED STARS (1926)

	Alpha Androm. (Alpheratz)			Beta Cassiop. (Caph)			Beta Ceti (Daneb Kaitos)		
	c **60°** ′	log cosec *c*	RAN+*n* **180°** ′	*c* **30°** ′	log cosec *c*	RAN+*n* **180°** ′	*c* **107°** ′	log cosec *c*	RAN+*n* **190°** ′
1926									
Jan. 1	18.8	.06110	54.0	15.1	.29774	35.5	20.4	.02020	2.9
11	18.8	.06110	54.0	15.1	.29774	35.5	20.4	.02020	2.8
21	18.9	.06110	54.0	15.2	.29772	35.5	20.4	.02020	2.8
31	18.9	.06110	54.0	15.2	.29772	35.5	20.4	.02020	2.7
Feb. 10	18.8	.06110	54.0	15.2	.29772	35.5	20.3	.02019	2.7
20	18.8	.06110	54.0	15.2	.29772	35.5	20.3	.02019	2.7
Mar. 2	18.8	.06110	54.0	15.2	.29772	35.6	20.2	.02019	2.7
12	18.8	.06110	54.0	15.2	.29772	35.6	20.2	.02019	2.6
22	18.8	.06110	54.0	15.1	.29774	35.6	20.1	.02018	2.6
Apr. 1	18.7	.06111	54.0	15.1	.29774	35.6	20.0	.02018	2.6
11	18.7	.06111	54.1	15.1	.29774	35.6	19.9	.02018	2.7
21	18.6	.06112	54.1	15.1	.29774	35.6	19.8	.02017	2.7
May 1	18.6	.06112	54.1	15.1	.29774	35.7	19.8	.02017	2.7
11	18.6	.06112	54.2	15.1	.29774	35.7	19.7	.02017	2.8
21	18.5	.06112	54.2	15.1	.29774	35.7	19.6	.02016	2.9
31	18.5	.06112	54.3	15.1	.29774	35.8	19.6	.02016	3.0
June 10	18.5	.06112	54.3	15.0	.29776	35.8	19.5	.02016	3.1
20	18.5	.06112	54.4	15.0	.29776	35.8	19.5	.02016	3.1
30	18.4	.06113	54.4	15.0	.29776	35.9	19.4	.02016	3.2
July 10	18.4	.06113	54.5	15.0	.29776	35.9	19.4	.02016	3.3
20	18.4	.06113	54.5	15.0	.29776	36.0	19.4	.02016	3.4
30	18.4	.06113	54.6	15.0	.29776	36.0	19.4	.02016	3.5
Aug. 9	18.4	.06113	54.6	15.0	.29776	36.0	19.4	.02016	3.6
19	18.4	.06113	54.7	15.0	.29776	36.1	19.5	.02016	3.7
29	18.4	.06113	54.7	15.0	.29776	36.1	19.5	.02016	3.7
Sep. 8	18.5	.06112	54.7	15.0	.29776	36.1	19.6	.02016	3.8
18	18.5	.06112	54.8	15.0	.29776	36.1	19.7	.02017	3.8
28	18.5	.06112	54.8	15.0	.29776	36.1	19.7	.02017	3.9
Oct. 8	18.6	.06112	54.8	15.0	.29776	36.1	19.8	.02017	3.9
17	18.6	.06112	54.8	15.0	.29776	36.2	19.9	.02018	3.9
27	18.6	.06112	54.8	15.1	.29774	36.2	20.0	.02018	3.9
Nov. 6	18.7	.06111	54.8	15.1	.29774	36.2	20.1	.02018	3.9
16	18.7	.06111	54.8	15.1	.29774	36.2	20.1	.02018	3.8
26	18.7	.06111	54.8	15.1	.29774	36.2	20.2	.02019	3.8
Dec. 6	18.8	.06110	54.8	15.1	.29774	36.2	20.3	.02019	3.8
16	18.8	.06110	54.8	15.1	.29774	36.2	20.3	.02019	3.7
26	18.8	.06110	54.8	15.1	.29774	36.2	20.3	.02019	3.7
1927									
Jan. 1	18.8	.06110	54.8	15.1	.29774	36.3	20.4	.02020	3.7

TABLE VII—(*Continued*)

VALUES OF c, LOG COSEC c, AND RAN + n FOR 27 SELECTED STARS (1926)

	Alpha Arietis (Hamal)			Alpha Persei (Mirfak)			Alpha Tauri (Aldebaran)		
1926	c 65° ′	log cosec c	RAN + n 210° ′	c 39° ′	log cosec c	RAN + n 230° ′	c 72° ′	log cosec c	RAN + n 248° ′
Jan. 1	48.4	.03993	48.3	25.4	.19720	20.1	51.6	.01973	8.8
11	48.5	.03992	48.3	25.5	.19718	20.1	51.7	.01972	8.9
21	48.5	.03992	48.3	25.5	.19718	20.1	51.7	.01972	8.8
31	48.5	.03992	48.3	25.5	.19718	20.1	51.7	.01972	8.8
Feb. 10	48.5	.03992	48.3	25.5	.19718	20.1	51.8	.01972	8.8
20	48.5	.03992	48.3	25.5	.19718	20.1	51.8	.01972	8.8
Mar. 2	48.5	.03992	48.3	25.5	.19718	20.1	51.8	.01972	8.7
12	48.5	.03992	48.2	25.5	.19718	20.1	51.8	.01972	8.7
22	48.4	.03993	48.2	25.5	.19718	20.1	51.8	.01972	8.7
Apr. 1	48.4	.03993	48.2	25.5	.19718	20.1	51.8	.01972	8.7
11	48.3	.03993	48.2	25.5	.19718	20.1	51.7	.01972	8.6
21	48.3	.03993	48.3	25.4	.19720	20.1	51.7	.01972	8.6
May 1	48.2	.03994	48.3	25.4	.19720	20.1	51.6	.01973	8.6
11	48.2	.03994	48.3	25.4	.19720	20.1	51.6	.01973	8.6
21	48.1	.03994	48.3	25.4	.19720	20.1	51.5	.01973	8.6
31	48.1	.03994	48.4	25.4	.19720	20.2	51.5	.01973	8.7
June 10	48.1	.03994	48.4	25.3	.19721	20.2	51.4	.01973	8.7
20	48.0	.03995	48.5	25.3	.19721	20.2	51.4	.01973	8.7
30	48.0	.03995	48.5	25.3	.19721	20.3	51.3	.01974	8.8
July 10	48.0	.03995	48.6	25.3	.19721	20.3	51.2	.01974	8.8
20	47.9	.03996	48.7	25.2	.19723	20.3	51.2	.01974	8.9
30	47.9	.03996	48.7	25.2	.19723	20.4	51.2	.01974	8.9
Aug. 9	47.9	.03996	48.8	25.2	.19723	20.4	51.1	.01975	9.0
19	47.9	.03996	48.8	25.2	.19723	20.5	51.1	.01975	9.1
29	47.9	.03996	48.9	25.2	.19723	20.5	51.1	.01975	9.1
Sep. 8	47.9	.03996	48.9	25.2	.19723	20.5	51.1	.01975	9.2
18	48.0	.03995	49.0	25.2	.19723	20.6	51.1	.01975	9.2
28	48.0	.03995	49.0	25.2	.19723	20.6	51.1	.01975	9.3
Oct. 8	48.0	.03995	49.0	25.2	.19723	20.6	51.1	.01975	9.3
17	48.1	.03994	49.0	25.2	.19723	20.7	51.2	.01974	9.4
27	48.1	.03994	49.1	25.3	.19721	20.7	51.2	.01974	9.4
Nov. 6	48.2	.03994	49.1	25.3	.19721	20.7	51.3	.01974	9.5
16	48.2	.03994	49.1	25.3	.19721	20.7	51.3	.01974	9.5
26	48.3	.03993	49.1	25.3	.19721	20.8	51.4	.01973	9.5
Dec. 6	48.3	.03993	49.1	25.4	.19720	20.8	51.4	.01973	9.6
16	48.4	.03993	49.1	25.4	.19720	20.8	51.5	.01973	9.6
26	48.4	.03993	49.1	25.4	.19720	20.8	51.6	.01973	9.6
1927 Jan. 1	48.4	.03993	49.1	25.4	.19720	20.8	51.6	.01973	9.6

TABLE VII—(*Continued*)

VALUES OF *c*, LOG COSEC *c*, AND RAN + *n* FOR 27 SELECTED STARS (1926)

	Beta Orionis (Rigel)			Alpha Aurigae (Capella)			Alpha Orionis (Betelgeux)		
1926	*c* 97° ′	log cosec *c*	RAN+*n* 257° ′	*c* 43° ′	log cosec *c*	RAN+*n* 258° ′	*c* 82° ′	log cosec *c*	RAN+*n* 267° ′
Jan. 1	38.8	.00388	37.4	26.6	.16264	43.9	7.9	.00411	55.4
11	38.9	.00388	37.4	26.6	.16264	44.0	7.9	.00411	55.4
21	39.0	.00388	37.4	26.7	.16263	44.0	8.0	.00411	55.4
31	39.0	.00388	37.4	26.7	.16263	44.0	8.1	.00411	55.4
Feb. 10	39.1	.00388	37.3	26.7	.16263	44.0	8.1	.00411	55.4
20	39.1	.00388	37.3	26.7	.16263	44.0	8.1	.00411	55.4
Mar. 2	39.1	.00388	37.2	26.7	.16263	44.0	8.2	.00411	55.4
12	39.1	.00388	37.2	26.7	.16263	43.9	8.2	.00411	55.3
22	39.1	.00388	37.1	26.7	.16263	43.9	8.2	.00411	55.3
Apr. 1	39.1	.00388	37.1	26.7	.16263	43.9	8.2	.00411	55.2
11	39.1	.00388	37.0	26.7	.16263	43.9	8.2	.00411	55.2
21	39.0	.00388	37.0	26.7	.16263	43.9	8.1	.00411	55.2
May 1	39.0	.00388	37.0	26.7	.16263	43.9	8.1	.00411	55.2
11	38.9	.00388	37.0	26.7	.16263	43.9	8.0	.00411	55.1
21	38.8	.00388	37.0	26.6	.16264	43.9	8.0	.00411	55.1
31	38.7	.00388	37.0	26.6	.16264	44.0	7.9	.00411	55.1
June 10	38.7	.00388	37.0	26.6	.16264	44.0	7.8	.00411	55.2
20	38.6	.00388	37.0	26.5	.16266	44.0	7.8	.00411	55.2
30	38.5	.00388	37.1	26.5	.16266	44.0	7.7	.00411	55.2
July 10	38.4	.00387	37.1	26.5	.16266	44.1	7.6	.00411	55.3
20	38.3	.00387	37.2	26.5	.16266	44.1	7.6	.00411	55.3
30	38.3	.00387	37.2	26.4	.16267	44.2	7.5	.00412	55.4
Aug. 9	38.2	.00387	37.3	26.4	.16267	44.2	7.5	.00412	55.4
19	38.2	.00387	37.4	26.4	.16267	44.2	7.4	.00412	55.5
29	38.2	.00387	37.5	26.4	.16267	44.3	7.4	.00412	55.5
Sep. 8	38.2	.00387	37.5	26.4	.16267	44.3	7.4	.00412	55.6
18	38.2	.00387	37.6	26.4	.16267	44.4	7.4	.00412	55.7
28	38.2	.00387	37.7	26.4	.16267	44.4	7.4	.00412	55.7
Oct. 8	38.2	.00387	37.8	26.4	.16267	44.4	7.4	.00412	55.8
17	38.2	.00387	37.9	26.4	.16267	44.5	7.4	.00412	55.8
27	38.3	.00387	37.9	26.4	.16267	44.5	7.5	.00412	55.9
Nov. 6	38.4	.00387	38.0	26.5	.16266	44.5	7.5	.00412	56.0
16	38.4	.00387	38.0	26.5	.16266	44.6	7.6	.00411	56.0
26	38.5	.00388	38.1	26.5	.16266	44.6	7.6	.00411	56.1
Dec. 6	38.6	.00388	38.1	26.5	.16266	44.6	7.7	.00411	56.1
16	38.7	.00388	38.1	26.6	.16264	44.7	7.8	.00411	56.1
26	38.8	.00388	38.2	26.6	.16264	44.7	7.8	.00411	56.2
1927 Jan. 1	38.8	.00388	38.2	26.6	.16264	44.7	7.9	.00411	56.2

TABLE VII—(*Continued*)

VALUES OF *c*, LOG COSEC *c*, AND RAN + *n* FOR 27 SELECTED STARS (1926)

	Alpha Can. Maj. (Sirius)			Alpha Can. Min. (Procyon)			Beta Gemin. (Pollux)		
1926	*c* **106°** ′	log cosec *c*	RAN+*n* **280°** ′	*c* **84°** ′	log cosec *c*	RAN+*n* **293°** ′	*c* **61°** ′	log cosec *c*	RAN+*n* **295°** ′
Jan. 1	21.7	.01795	9.6	35.2	.00194	57.7	49.7	.05476	46.9
11	21.8	.01795	9.7	35.3	.00194	57.7	49.7	.05476	47.0
21	21.9	.01796	9.7	35.4	.00194	57.8	49.8	.05475	47.0
31	22.0	.01796	9.7	35.5	.00194	57.8	49.8	.05475	47.0
Feb. 10	22.0	.01796	9.6	35.5	.00194	57.8	49.9	.05475	47.0
20	22.1	.01796	9.6	35.6	.00193	57.8	49.9	.05475	47.0
Mar. 2	22.2	.01797	9.5	35.6	.00193	57.7	49.9	.05475	47.0
12	22.2	.01797	9.4	35.7	.00193	57.7	49.9	.05475	47.0
22	22.2	.01797	9.4	35.7	.00193	57.7	50.0	.05474	46.9
Apr. 1	22.2	.01797	9.3	35.7	.00193	57.6	50.0	.05474	46.9
11	22.2	.01797	9.3	35.7	.00193	57.6	50.0	.05474	46.9
21	22.2	.01797	9.2	35.7	.00193	57.6	50.0	.05474	46.9
May 1	22.1	.01796	9.2	35.7	.00193	57.5	49.9	.05475	46.9
11	22.1	.01796	9.1	35.6	.00193	57.5	49.9	.05475	46.9
21	22.0	.01796	9.1	35.6	.00193	57.5	49.9	.05475	46.9
31	21.9	.01796	9.1	35.5	.00194	57.5	49.9	.05475	46.9
June 10	21.8	.01795	9.1	35.5	.00194	57.5	49.8	.05475	46.9
20	21.8	.01795	9.1	35.4	.00194	57.5	49.8	.05475	46.9
30	21.7	.01795	9.1	35.4	.00194	57.5	49.7	.05476	46.9
July 10	21.6	.01795	9.1	35.3	.00194	57.5	49.7	.05476	46.9
20	21.5	.01794	9.2	35.2	.00194	57.5	49.6	.05477	46.9
30	21.4	.01794	9.2	35.2	.00194	57.6	49.6	.05477	47.0
Aug. 9	21.3	.01794	9.3	35.1	.00194	57.6	49.5	.05478	47.0
19	21.3	.01794	9.3	35.0	.00194	57.6	49.5	.05478	47.0
29	21.2	.01794	9.4	35.0	.00194	57.7	49.5	.05478	47.1
Sep. 8	21.2	.01794	9.5	34.9	.00194	57.7	49.4	.05478	47.1
18	21.2	.01794	9.6	34.9	.00194	57.8	49.4	.05478	47.1
28	21.2	.01794	9.7	34.9	.00194	57.9	49.4	.05478	47.2
Oct. 8	21.2	.01794	9.8	34.9	.00194	57.9	49.4	.05478	47.2
17	21.2	.01794	9.9	34.9	.00194	58.0	49.4	.05478	47.3
27	21.2	.01794	10.0	34.9	.00194	58.1	49.4	.05478	47.3
Nov. 6	21.3	.01794	10.0	34.9	.00194	58.1	49.4	.05478	47.4
16	21.3	.01794	10.1	35.0	.00194	58.2	49.5	.05478	47.4
26	21.4	.01794	10.2	35.0	.00194	58.3	49.5	.05478	47.5
Dec. 6	21.5	.01794	10.3	35.1	.00194	58.3	49.5	.05478	47.5
16	21.6	.01795	10.3	35.1	.00194	58.4	49.6	.05477	47.6
26	21.7	.01795	10.4	35.2	.00194	58.4	49.6	.05477	47.6
1927 Jan. 1	21.7	.01795	10.4	35.3	.00194	58.5	49.7	.05476	47.7

TABLE VII—(*Continued*)

VALUES OF c, LOG COSEC c, AND RAN + n FOR 27 SELECTED STARS (1926)

	Alpha Hydrae (Alphard)			Alpha Leonis (Regulus)			Alpha Urs. Maj. (Dubhe)		
	c	log cosec c	RAN+n	c	log cosec c	RAN+n	c	log cosec c	RAN+n
	98°		**320°**	**78°**		**331°**	**28°**		**346°**
1926	′		′	′		′	′		′
Jan. 1	50.0	.00518	50.5	19.9	.00907	17.5	42.4	.31847	2.9
11	50.1	.00518	50.6	20.0	.00907	17.5	42.4	.31847	2.9
21	50.1	.00518	50.7	20.1	.00907	17.6	42.4	.31847	3.0
31	50.2	.00518	50.7	20.1	.00907	17.6	42.4	.31847	3.0
Feb. 10	50.3	.00519	50.7	20.2	.00906	17.7	42.4	.31847	3.0
20	50.4	.00519	50.7	20.2	.00906	17.7	42.4	.31847	3.0
Mar. 2	50.4	.00519	50.7	20.3	.00906	17.7	42.4	.31847	3.0
12	50.5	.00519	50.7	20.3	.00906	17.7	42.5	.31844	3.1
22	50.6	.00519	50.7	20.4	.00906	17.7	42.5	.31844	3.1
Apr. 1	50.6	.00519	50.6	20.4	.00906	17.7	42.5	.31844	3.1
11	50.6	.00519	50.6	20.4	.00906	17.7	42.5	.31844	3.1
21	50.7	.00519	50.6	20.5	.00906	17.6	42.5	.31844	3.1
May 1	50.7	.00519	50.5	20.5	.00906	17.6	42.5	.31844	3.1
11	50.7	.00519	50.5	20.5	.00906	17.6	42.5	.31844	3.1
21	50.6	.00519	50.4	20.5	.00906	17.6	42.5	.31844	3.1
31	50.6	.00519	50.4	20.4	.00906	17.5	42.5	.31844	3.1
June 10	50.6	.00519	50.4	20.4	.00906	17.5	42.4	.31847	3.1
20	50.5	.00519	50.3	20.4	.00906	17.5	42.4	.31847	3.2
30	50.4	.00519	50.3	20.3	.00906	17.5	42.4	.31847	3.2
July 10	50.4	.00519	50.3	20.3	.00906	17.5	42.4	.31847	3.2
20	50.3	.00519	50.3	20.2	.00906	17.5	42.4	.31847	3.2
30	50.2	.00518	50.3	20.2	.00906	17.5	42.4	.31847	3.2
Aug. 9	50.1	.00518	50.3	20.1	.00907	17.5	42.4	.31847	3.2
19	50.1	.00518	50.3	20.0	.00907	17.5	42.3	.31849	3.2
29	50.0	.00518	50.4	20.0	.00907	17.5	42.3	.31849	3.3
Sep. 8	49.9	.00518	50.4	19.9	.00907	17.6	42.3	.31849	3.3
18	49.9	.00518	50.5	19.9	.00907	17.6	42.3	.31849	3.3
28	49.8	.00518	50.5	19.8	.00907	17.6	42.3	.31849	3.3
Oct. 8	49.8	.00518	50.6	19.8	.00907	17.7	42.3	.31849	3.3
17	49.7	.00517	50.7	19.8	.00907	17.7	42.3	.31849	3.4
27	49.7	.00517	50.7	19.8	.00907	17.8	42.3	.31849	3.4
Nov. 6	49.7	.00517	50.8	19.8	.00907	17.8	42.3	.31849	3.4
16	49.7	.00517	50.9	19.8	.00907	17.9	42.3	.31849	3.4
26	49.8	.00518	51.0	19.8	.00907	18.0	42.3	.31849	3.5
Dec. 6	49.8	.00518	51.1	19.8	.00907	18.0	42.3	.31849	3.5
16	49.9	.00518	51.2	19.9	.00907	18.1	42.3	.31849	3.6
26	49.9	.00518	51.2	19.9	.00907	18.2	42.4	.31847	3.6
1927									
Jan. 1	50.0	.00518	51.3	20.0	.00907	18.2	42.4	.31847	3.6

TABLE VII—(*Continued*)

VALUES OF c, LOG COSEC c, AND RAN + n FOR 27 SELECTED STARS (1926)

	Beta Leonis (Denebola)			Alpha Virginis (Spica)			Eta Urs. Maj. (Alkaid)		
1926	c 75° ′	log cosec c	RAN+n 356° ′	c 101° ′	log cosec c	RAN+n 20° ′	c 41° ′	log cosec c	RAN+n 26° ′
Jan. 1	58.8	.01314	26.9	51.6	.00937	18.3	24.5	.17952	5.9
11	58.9	.01313	27.0	51.6	.00937	18.4	24.5	.17952	6.0
21	58.9	.01313	27.0	51.6	.00937	18.5	24.5	.17952	6.0
31	59.0	.01313	27.1	51.6	.00937	18.6	24.5	.17952	6.1
Feb. 10	59.0	.01313	27.1	51.7	.00937	18.7	24.5	.17952	6.1
20	59.1	.01313	27.2	51.8	.00938	18.7	24.5	.17952	6.1
Mar. 2	59.1	.01313	27.2	51.8	.00938	18.8	24.6	.17951	6.2
12	59.2	.01312	27.2	51.9	.00938	18.8	24.6	.17951	6.2
22	59.2	.01312	27.2	51.9	.00938	18.9	24.6	.17951	6.2
Apr. 1	59.3	.01312	27.2	52.0	.00938	18.9	24.6	.17951	6.2
11	59.3	.01312	27.2	52.1	.00938	18.9	24.6	.17951	6.2
21	59.3	.01312	27.2	52.1	.00938	19.0	24.6	.17951	6.3
May 1	59.3	.01312	27.2	52.2	.00939	19.0	24.6	.17951	6.3
11	59.4	.01312	27.2	52.2	.00939	19.0	24.6	.17951	6.3
21	59.4	.01312	27.2	52.2	.00939	18.9	24.6	.17951	6.3
31	59.4	.01312	27.2	52.3	.00939	18.9	24.6	.17951	6.3
June 10	59.3	.01312	27.2	52.3	.00939	18.9	24.6	.17951	6.3
20	59.3	.01312	27.2	52.3	.00939	18.9	24.6	.17951	6.3
30	59.3	.01312	27.1	52.3	.00939	18.8	24.6	.17951	6.4
July 10	59.3	.01312	27.1	52.3	.00939	18.8	24.6	.17951	6.4
20	59.2	.01312	27.1	52.3	.00939	18.7	24.6	.17951	6.4
30	59.2	.01312	27.1	52.2	.00939	18.7	24.6	.17951	6.4
Aug. 9	59.1	.01313	27.1	52.2	.00939	18.7	24.5	.17952	6.4
19	59.1	.01313	27.1	52.1	.00938	18.6	24.5	.17952	6.4
29	59.0	.01313	27.1	52.1	.00938	18.6	24.5	.17952	6.4
Sep. 8	59.0	.01313	27.1	52.0	.00938	18.6	24.5	.17952	6.4
18	58.9	.01313	27.1	52.0	.00938	18.6	24.5	.17952	6.4
28	58.9	.01313	27.1	51.9	.00938	18.5	24.5	.17952	6.4
Oct. 8	58.9	.01313	27.2	51.8	.00938	18.5	24.5	.17952	6.4
17	58.8	.01314	27.2	51.8	.00938	18.6	24.4	.17953	6.4
27	58.8	.01314	27.2	51.7	.00937	18.6	24.4	.17953	6.4
Nov. 6	58.8	.01314	27.3	51.7	.00937	18.6	24.4	.17953	6.4
16	58.8	.01314	27.3	51.6	.00937	18.7	24.4	.17953	6.5
26	58.8	.01314	27.4	51.6	.00937	18.7	24.4	.17953	6.5
Dec. 6	58.8	.01314	27.5	51.6	.00937	18.8	24.4	.17953	6.5
16	58.8	.01314	27.5	51.5	.00937	18.9	24.4	.17953	6.6
26	58.8	.01314	27.6	51.5	.00937	19.0	24.5	.17952	6.6
1927 Jan. 1	58.8	.01314	27.6	51.5	.00937	19.0	24.5	.17952	6.7

TABLE VII—(*Continued*)

VALUES OF c, LOG COSEC c, AND RAN + n FOR 27 SELECTED STARS (1926)

	Alpha Boötis (Arcturus)			Alpha Cor. Bor. (Alphecca)			Alpha Ophiuchi (Rasalhague)		
1926	c 71° ′	log cosec c	RAN+n 33° ′	c 63° ′	log cosec c	RAN+n 52° ′	c 77° ′	log cosec c	RAN+n 82° ′
Jan. 1	30.4	.02302	0.3	59.4	.04638	37.1	56.8	.00968	39.7
11	30.4	.02302	0.4	59.4	.04638	37.1	56.8	.00968	39.7
21	30.4	.02302	0.4	59.4	.04638	37.2	56.8	.00968	39.8
31	30.5	.02302	0.5	59.4	.04638	37.3	56.8	.00968	39.9
Feb. 10	30.5	.02302	0.5	59.4	.04638	37.3	56.8	.00968	39.9
20	30.5	.02302	0.6	59.4	.04638	37.4	56.8	.00968	40.0
Mar. 2	30.5	.02302	0.6	59.4	.04638	37.4	56.8	.00968	40.0
12	30.6	.02302	0.7	59.5	.04637	37.5	56.8	.00968	40.1
22	30.6	.02302	0.7	59.5	.04637	37.5	56.8	.00968	40.2
Apr. 1	30.6	.02302	0.7	59.5	.04637	37.5	56.8	.00968	40.2
11	30.7	.02301	0.8	59.5	.04637	37.6	56.8	.00968	40.3
21	30.7	.02301	0.8	59.5	.04637	37.6	56.8	.00968	40.3
May 1	30.7	.02301	0.8	59.6	.04636	37.6	56.8	.00968	40.4
11	30.8	.02301	0.8	59.6	.04636	37.7	56.8	.00968	40.4
21	30.8	.02301	0.8	59.6	.04636	37.7	56.9	.00968	40.5
31	30.8	.02301	0.8	59.6	.04636	37.7	56.9	.00968	40.5
June 10	30.8	.02301	0.8	59.6	.04636	37.7	56.9	.00968	40.5
20	30.8	.02301	0.8	59.6	.04636	37.7	56.9	.00968	40.6
30	30.8	.02301	0.8	59.6	.04636	37.7	56.9	.00968	40.6
July 10	30.8	.02301	0.8	59.6	.04636	37.7	57.0	.00968	40.6
20	30.8	.02301	0.8	59.6	.04636	37.7	57.0	.00968	40.6
30	30.7	.02301	0.8	59.6	.04636	37.7	57.0	.00968	40.6
Aug. 9	30.7	.02301	0.8	59.6	.04636	37.7	57.0	.00968	40.6
19	30.7	.02301	0.8	59.6	.04636	37.7	57.0	.00968	40.6
29	30.7	.02301	0.7	59.6	.04636	37.7	57.0	.00968	40.5
Sep. 8	30.6	.02302	0.7	59.5	.04637	37.7	57.0	.00968	40.5
18	30.6	.02302	0.7	59.5	.04637	37.6	57.0	.00968	40.5
28	30.6	.02302	0.7	59.5	.04637	37.6	57.0	.00968	40.4
Oct. 8	30.6	.02302	0.7	59.5	.04637	37.6	57.0	.00968	40.4
17	30.5	.02302	0.7	59.5	.04637	37.6	57.0	.00968	40.4
27	30.5	.02302	0.7	59.4	.04638	37.6	57.0	.00968	40.4
Nov. 6	30.5	.02302	0.7	59.4	.04638	37.6	57.0	.00968	40.3
16	30.5	.02302	0.8	59.4	.04638	37.6	56.9	.00968	40.3
26	30.4	.02302	0.8	59.4	.04638	37.7	56.9	.00968	40.3
Dec. 6	30.4	.02302	0.9	59.4	.04638	37.7	56.9	.00968	40.4
16	30.4	.02302	0.9	59.4	.04638	37.7	56.9	.00968	40.4
26	30.4	.02302	1.0	59.4	.04638	37.8	56.9	.00968	40.4
1927									
Jan. 1	30.4	.02302	1.0	59.4	.04638	37.8	56.9	.00968	40.4

TABLE VII—(*Continued*)

VALUES OF c, LOG COSEC c, AND RAN + n FOR 27 SELECTED STARS (1926)

	Gamma Draconis (Etamin)			Alpha Lyrae (Vega)			Alpha Aquilae (Altair)		
1926	c **38°** ′	log cosec c	RAN + n **87°** ′	c **51°** ′	log cosec c	RAN + n **97°** ′	c **81°** ′	log cosec c	RAN + n **116°** ′
Jan. 1	58.5	.20136	29.3	34.7	.10598	45.8	16.4	.00506	37.1
11	58.5	.20136	29.4	34.7	.10598	45.8	16.3	.00506	37.1
21	58.5	.20136	29.4	34.7	.10598	45.8	16.3	.00506	37.1
31	58.5	.20136	29.4	34.7	.10598	45.9	16.3	.00506	37.2
Feb. 10	58.5	.20136	29.5	34.7	.10598	45.9	16.3	.00506	37.2
20	58.5	.20136	29.5	34.7	.10598	45.9	16.2	.00506	37.2
Mar. 2	58.5	.20136	29.5	34.7	.10598	46.0	16.2	.00506	37.3
12	58.5	.20136	29.5	34.7	.10598	46.0	16.2	.00506	37.3
22	58.5	.20136	29.6	34.7	.10598	46.1	16.1	.00506	37.4
Apr. 1	58.5	.20136	29.6	34.7	.10598	46.1	16.1	.00506	37.5
11	58.5	.20136	29.6	34.7	.10598	46.1	16.1	.00506	37.5
21	58.5	.20136	29.7	34.7	.10598	46.2	16.1	.00506	37.6
May 1	58.5	.20136	29.7	34.7	.10598	46.2	16.1	.00506	37.7
11	58.5	.20136	29.8	34.7	.10598	46.3	16.1	.00506	37.7
21	58.5	.20136	29.8	34.7	.10598	46.3	16.1	.00506	37.8
31	58.5	.20136	29.8	34.7	.10598	46.4	16.1	.00506	37.8
June 10	58.5	.20136	29.9	34.7	.10598	46.4	16.1	.00506	37.9
20	58.5	.20136	29.9	34.7	.10598	46.4	16.1	.00506	37.9
30	58.5	.20136	29.9	34.7	.10598	46.5	16.1	.00506	38.0
July 10	58.5	.20136	29.9	34.7	.10598	46.5	16.1	.00506	38.0
20	58.5	.20136	29.9	34.7	.10598	46.5	16.2	.00506	38.0
30	58.5	.20136	30.0	34.7	.10598	46.5	16.2	.00506	38.1
Aug. 9	58.5	.20136	30.0	34.7	.10598	46.5	16.2	.00506	38.1
19	58.5	.20136	30.0	34.7	.10598	46.5	16.3	.00506	38.1
29	58.5	.20136	30.0	34.7	.10598	46.5	16.3	.00506	38.1
Sep. 8	58.5	.20136	30.0	34.7	.10598	46.5	16.3	.00506	38.0
18	58.5	.20136	30.0	34.7	.10598	46.5	16.3	.00506	38.0
28	58.5	.20136	29.9	34.7	.10598	46.5	16.4	.00506	38.0
Oct. 8	58.5	.20136	29.9	34.7	.10598	46.5	16.4	.00506	38.0
17	58.5	.20136	29.9	34.7	.10598	46.4	16.4	.00506	37.9
27	58.5	.20136	29.9	34.7	.10598	46.4	16.4	.00506	37.9
Nov. 6	58.5	.20136	29.9	34.7	.10598	46.4	16.4	.00506	37.9
16	58.5	.20136	30.0	34.7	.10598	46.4	16.4	.00506	37.8
26	58.5	.20136	30.0	34.7	.10598	46.4	16.4	.00506	37.8
Dec. 6	58.5	.20136	30.0	34.7	.10598	46.5	16.4	.00506	37.8
16	58.5	.20136	30.0	34.7	.10598	46.5	16.4	.00506	37.8
26	58.5	.20136	30.0	34.7	.10598	46.5	16.4	.00506	37.8
1927 Jan. 1	58.5	.20136	30.0	34.7	.10598	46.5	16.3	.00506	37.8

TABLE VII—(*Continued*)

VALUES OF *c*, LOG COSEC *c*, AND RAN + *n* FOR 27 SELECTED STARS (1926)

	Alpha Cygni (Deneb)			Epsilon Pegasi (Enif)			Alpha Pegasi (Markab)		
1926	*c* 44° ′	log cosec *c*	RAN+*n* 128° ′	*c* 79° ′	log cosec *c*	RAN+*n* 144° ′	*c* 74° ′	log cosec *c*	RAN+*n* 165° ′
Jan. 1	41.6	.15285	39.8	54.0	.00678	58.2	20.6	.01642	4.6
11	41.6	.15285	39.8	54.0	.00678	58.2	20.6	.01642	4.6
21	41.6	.15285	39.8	54.0	.00678	58.2	20.6	.01642	4.6
31	41.6	.15285	39.9	53.9	.00678	58.2	20.6	.01642	4.6
Feb. 10	41.6	.15285	39.9	53.9	.00678	58.2	20.5	.01642	4.6
20	41.6	.15285	39.9	53.9	.00678	58.2	20.5	.01642	4.6
Mar. 2	41.6	.15285	39.9	53.8	.00679	58.2	20.5	.01642	4.6
12	41.6	.15285	40.0	53.8	.00679	58.3	20.4	.01643	4.7
22	41.6	.15285	40.0	53.8	.00679	58.3	20.4	.01643	4.7
Apr. 1	41.6	.15285	40.0	53.8	.00679	58.3	20.4	.01643	4.7
11	41.6	.15285	40.1	53.7	.00679	58.4	20.3	.01643	4.7
21	41.6	.15285	40.1	53.7	.00679	58.5	20.3	.01643	4.8
May 1	41.5	.15286	40.1	53.7	.00679	58.5	20.2	.01643	4.8
11	41.5	.15286	40.2	53.6	.00679	58.6	20.2	.01643	4.9
21	41.5	.15286	40.2	53.6	.00679	58.6	20.2	.01643	5.0
31	41.5	.15286	40.3	53.6	.00679	58.7	20.1	.01644	5.0
June 10	41.5	.15286	40.3	53.6	.00679	58.8	20.1	.01644	5.1
20	41.5	.15286	40.4	53.6	.00679	58.8	20.1	.01644	5.1
30	41.5	.15286	40.4	53.5	.00680	58.9	20.1	.01644	5.2
July 10	41.5	.15286	40.4	53.5	.00680	59.0	20.1	.01644	5.3
20	41.5	.15286	40.5	53.5	.00680	59.0	20.1	.01644	5.3
30	41.5	.15286	40.5	53.6	.00679	59.0	20.1	.01644	5.4
Aug. 9	41.5	.15286	40.5	53.6	.00679	59.1	20.1	.01644	5.4
19	41.5	.15286	40.5	53.6	.00679	59.1	20.1	.01644	5.5
29	41.5	.15286	40.5	53.6	.00679	59.1	20.2	.01643	5.5
Sep. 8	41.5	.15286	40.5	53.7	.00679	59.1	20.2	.01643	5.5
18	41.5	.15286	40.5	53.7	.00679	59.1	20.2	.01643	5.5
28	41.6	.15285	40.5	53.8	.00679	59.1	20.3	.01643	5.5
Oct. 8	41.6	.15285	40.5	53.8	.00679	59.1	20.3	.01643	5.5
17	41.6	.15285	40.5	53.9	.00678	59.1	20.4	.01643	5.5
27	41.6	.15285	40.5	53.9	.00678	59.0	20.4	.01643	5.5
Nov. 6	41.6	.15285	40.5	54.0	.00678	59.0	20.5	.01642	5.5
16	41.6	.15285	40.5	54.0	.00678	59.0	20.5	.01642	5.5
26	41.6	.15285	40.5	54.0	.00678	58.9	20.5	.01642	5.4
Dec. 6	41.6	.15285	40.5	54.0	.00678	58.9	20.5	.01642	5.4
16	41.6	.15285	40.5	54.0	.00678	58.9	20.6	.01642	5.4
26	41.6	.15285	40.5	54.0	.00678	58.9	20.6	.01642	5.4
1927 Jan. 1	41.6	.15285	40.5	54.0	.00678	58.9	20.6	.01642	5.4

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